Why the *Lock-In* Tube is at home IN THE AIR!

COMPACT . . . MADE TO FIT SMALL SPACES

This famous Sylvania product is ideal for use in air-borne radio equipment—it's so compact . . . has reduced overall height and weight. Further, it has no top cap connection . . . overhead wires are eliminated.

STAYS PUT IN SOCKET...THROUGH LOCK-IN FEATURE

No matter how rough the air, the tubes in an aircraft's radio will stay in their sockets —if those tubes are *Lock-Ins*. Specially designed "lock-in" locating lug on each tube keeps them in place—assuring firm socket contact.

ULTRA-HIGH FREQUENCIES...HANDLED WITH EASE

Lock-In is *the* tube specifically engineered to more than satisfy the requirements of today's sets, as well as handle ultra-high frequencies with ease! Electrical features include: short, direct connections . . . fewer welded joints—less loss; getter located on top . . . shorts eliminated by separation of getter material from leads. *See Sylvania Distributors or write Radio Division, Emporium, Pa.*

SYLVANIA'S LOCK-IN TUBE...

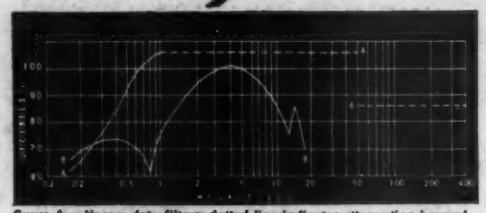
...the radio tube whose electrical and mechanical superiority makes it the ideal choice for equipment in the air, on the road, marine radar, FM and television.

SYLVANIA ELECTRIC

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

ISOLATION

...from extraneous radio interference...
for test rooms in laboratory or factory



Curve A — Heavy-duty filters; dotted line indicates attenuation beyond range of available measuring equipment.

Curve B — Medium-duty filters.

TOBE Screen Booth Filters

Installed where the electric power service passes through the screen, these Filterettes provide high attenuation from 150 kc to 400 mc, thus permitting operation of sensitive high-frequency test apparatus in close proximity to electric production equipment, welding generators, repulsion motors, and high-frequency induction heating equipment.

These units employ non-inductive, mineral-oil impregnated capacitors; the inductors, of large cross-section, have low series resistance, hence voltage drop is negligible. Overload ratings are: 150% of ampere rating for one hour; 200% of voltage rating for one minute. Since the filters have no saturable characteristics, performance is uniform for all loads up to maximum ratings.

SPECIFICATIONS

Mechanical design and assembly conform to practical electrical installation requirements. Outer housings are of welded steel; knockouts at each end accommodate electrical conduits; heavy, threaded studs facilitate attachment of cable lugs.

HEAVY DUTY FILTERS					
Type	Amperes	Volts	Volt. Drop	Freq. Range	Weight
No. 1179-A Two Wire	100	500 a-c/d-c	.2 volts per circuit	0.15 to 400 megacycles	40 lbs.
No. 1182-A Three Wire	100	500 a-c/d-c	.2 volts per circuit	0.15 to 400 megacycles	65 lbs.
MEDIUM DUTY FILTERS (Two Wire)					
No. 1137	20	110/220 a-c 500 d-c	.5 volts per circuit	0.15 to 20 megacycles	17 lbs.
No. 1116	50	110/220 a-c 500 d-c	.5 volts per circuit	0.15 to 20 megacycles	17 lbs.

TOBE

TOBE DEUTSCHMANN *Corporation* CANTON, MASSACHUSETTS

NOW - A SIXTY-FIVE WATT

- *Hard Glass*
- *Non-Emitting Grids*
- *Instant Heating Filament*
- *Low Drive*
- *Low Voltage*
- *Low Feed-Thru Capacitance*
- *Low Cost*

$14.50

TYPE 4-65A

ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	6.0 v
Current	3.5 amp
Grid-Screen Amp. Factor (Av.)	5
Direct Inter-Electrode Capacitances (average)	
Grid-Plate	0.08 μuf
Input	8.0 μuf
Output	2.1 μuf

TYPICAL OPERATION

Class C Telegraphy or FM Telephony (Key Down Conditions, 1 Tube)

D-C Plate voltage	400	1000	2000 v
D-C Screen voltage	250	250	250 v
D-C Grid voltage	−40	−50	−70 v
D-C Plate current	100	125	125 ma
D-C Screen current	40	37	35 ma
D-C Grid current	13	16	16 ma
Peak R-F grid input voltage	135	155	180 v
Driving power (approx)	1.8	2.5	2.9 w
Screen dissipation	10.0	9.2	8.8 w
Plate power input	40	125	250 w
Plate dissipation	12	30	50 w
Plate power output	28	95	200 w

THE ANSWER TO THE TRANSMITTER-MAN'S PRAYER

Available now, type 4-65A is a small radiation cooled, instant heating tetrode. Devoid of internal insulating hardware, the 4-65A was designed as a transmitting tube . . . not a blown-up receiving tube. This rugged new Eimac tetrode really performs at low voltage, and its instant heating thoriated tungsten filament makes it ideally suited for mobile installations. The 4-65A operates well into the VHF, beyond the 160-Mc. band, and is capable of delivering relatively high-power with a plate voltage range from 400 to 3000 volts. As do other Eimac tetrodes, type 4-65A embodies the inherent characteristics of low grid drive, low feed-thru capacitance, and general stability of operation.

Type 4-65A's versatility of operation is demonstrated in the adjacent data showing typical operation at 400, 1000, and 2000 volts. Additional data on the 4-65A are now available, write direct.

EITEL-McCULLOUGH, Inc.
1771 San Mateo Ave., San Bruno, California

Follow the Leaders to Eimac TUBES *The Power of R-F*

EXPORT AGENTS: FRAZAR AND HANSEN, 301 CLAY STREET
SAN FRANCISCO 11, CALIFORNIA, U.S.A.

The Solar System
electronics edition • August 1947

SOLITE* CAPACITORS IN HERMETICALLY SEALED METAL TUBES

THESE hermetically sealed small-size full-performance units fill a long-voiced demand on the part of designers of compact electronic devices. In addition, their self-healing characteristics are a noteworthy improvement in the capacitor art.

The photograph shows the space saving possible through the use of a .25 mf, 400 wvdc SOLITE aluminized paper capacitor instead of a conventional foil-paper unit. Mineral-wax filled and impregnated, SOLITE capacitors are designed for operation at ambient temperatures up to 85C.

These metal-encased tubular units are furnished with both insulated and uninsulated sections as Solar Types XTILWO and XTGLWO, respectively.

For cardboard or plastic outer sleeving, change the letter "O" in the type designation to "P" or "V" respectively.

Preferred ratings are as follows:

Catalog Number‡	Mf	WVDC	Dimensions in Inches† Diam.	Length
XTILWO2-.05	.05	200	3/8	29/32
XTILWO2-.1	.1	200	7/16	29/32
XTILWO2-.25	.25	200	1/2	29/32
XTILWO2-.5	.5	200	1/2	1 13/32
XTILWO2-1	1.0	200	.670	1 13/32
XTILWO2-2	2.0	200	.670	1 29/32
XTILWO2-4	4.0	200	1.0	1 29/32
XTILWO2-6	6.0	200	1.0	1 29/32
XTILWO4-.05	.05	400	1/2	29/32
XTILWO4-.1	.1	400	1/2	1 13/32
XTILWO4-.25	.25	400	.670	1 13/32
XTILWO4-.5	.5	400	.670	1 29/32
XTILWO4-1	1.0	400	3/4	2 13/32

Capacitance Tolerance: −20, +30 Percent, unless otherwise specified.
‡For grounded section XTGLWO units, deduct 1/8" from length.
†Add 1/16" to diameter and 1/4" to length for units with cardboard or plastic outer sleeving.
*Trade Mark

SOLAR "QUALITY ABOVE ALL"
SOLAR MANUFACTURING CORPORATION
1445 HUDSON BLVD., NORTH BERGEN, N. J.

BUSINESS BRIEFS

By W. W. MacDONALD

Normal Is The Word most freely bandied about at RMA's recent Chicago convention to describe the state of the radio receiver business. Set manufacturers now fully realize that the honeymoon is over, with all that this implies regarding the dangers of overproduction, excessive inventories, and the need for aggressive selling.

Retiring president Cosgrove said the industry would produce 18,000,000 home and auto radios in 1947, including 2,000,000 sets capable of receiving f-m programs. Television receiver production, he thinks, might reach 250,000. Radio receiver exports are at present 5 percent of the total, should reach 10 percent by the end of the year.

Banquet keynoter Sarnoff struck an "all this and heaven too" note when he said that the industry had an extremely bright future selling f-m receivers, home, theatre and industrial television, and industrial electronic devices, while at the same time continuing to do a good business in conventional radios and, particularly, record-playing combinations.

Anti-Excise Tax Efforts on the part of radio receiver manufacturers, with RMA leading the parade, continue in high gear. Our Washington expert on matters pertaining to feeling up on the Hill says it will be strictly no dice this session. Continued repetition of the fact that radio is a necessity, not a luxury, will nevertheless someday pay off, however, and we're all for it.

Television Receivers are so popular in the taverns of Philadelphia that it is not unusual for people who have just purchased a set to find a barkeep offering a premium for it on their doorstep the day after the set is installed. Philco's Jim McLean tells us that an unofficial survey around town indicates that pubs frequently increase their business threefold on the nights good sports programs are telecast.

Our own unofficial surveying among the taverns of New York, Chicago and cities in between indicates that the condition is widespread.

Electronic Equipment Prices concern just about everybody in the business. The other evening Bev Dudley, at one time Managing Editor of ELECTRONICS and now getting out MIT's *Technology Review*, engaged in some armchair research on the subject. He thumbed through the 1942 and 1947 catalogs of a well-known mail-order house, checking the prices of comparable items, and came up with the following tabulation:

Item	1942	1947	Ratio (%)
Five-tube three-way portable	$15.95	$37.95	238
Six-tube ac-dc table model	14.25	34.95	245
Communications receiver	259.50	353.85	136
Communications receiver	279.00	323.25	116
6V6 beam tube	.54	.75	139
80 rectifier	.32	.56	175
2A3 triode	1.13	1.33	118
6SK7 pentode	.54	.68	126
801A	3.45	3.00	87
807	3.50	2.30	66
Test oscillator	29.33	48.02	164
Audio oscillator	63.10	114.66	182
Signal generator	35.10	62.87	179
Capacitance analyzer	24.40	34.08	139
VU meter	23.52	25.87	110
Microphone	24.99	30.25	121
Microphone	14.70	16.08	109
12-inch electrodynamic speaker	10.14	19.40	191
A-B battery pack	3.55	5.62	158
Tuning capacitor	2.40	3.75	156
4-mfd 1,000 v. filter capacitor	3.67	5.58	152
4-mfd 1,000 v filter capacitor	2.79	4.23	152
Bell-ringing transformer	.46	.80	174
Universal driver transformer	2.21	5.10	231
Vernier dial	1.65	1.80	109
Crystal	7.75	8.75	113
Steel cabinet	3.80	5.59	147
Channel racks	10.70	16.17	151

Our Industry is well aware of the fact that it must sell itself to other industries; that it cannot expect the others to beat a path to its door. Conversation with an engineer employed by one of the largest automotive outfits in the country enroute to Chicago last month leads us to believe, however, that this consciousness of the need for selling does not go deep enough.

Several electronic engineers are employed by the automotive firm referred to above. They are good men. When mechanical and combustion engineers approach them for help in connection with a research or design problem, and tubes can solve the problem, the

warning service aboard 128 transports. Several other airlines have ordered samples for experimental installation, after witnessing demonstrations. Use of two sets per plane, one for obstacle-warning service and the other for navigational use, is a possibility.

Technical Problems the Army, Navy and Coast Guard would like to lick include the following:

Development of 8,000-40,000 volt rectifier tubes having lower filament drain.

Storage batteries having more satisfactory performance at low temperatures.

More accurate gages to show the draft and trim of vessels at sea.

Simpler roll indicator for vessels.

Effective naval fog detector.

Electronic device for instantly, positively and effectively igniting oil burners.

Miniature radio transmitter for use in lifeboats, rafts and floats.

Continuous-sampling combustible gas indicator.

National Inventors Council (Washington 25) can supply more details.

Rotating Machines may soon encounter stiffer competition from tubes in low-frequency (10 kc and below) induction heating service. Hydrogen thyratrons used as frequency converters appear to have distinct possibilities.

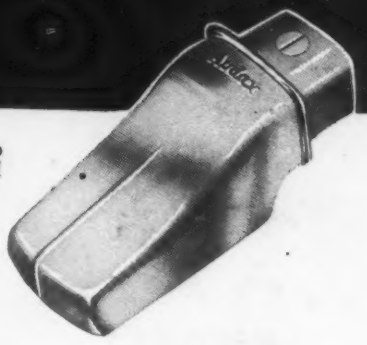
One Reason Why business will not fall as far, or stay down as long, as it did after the first world war is the placing of large government contracts with our industry. They won't avoid the blow. But they will soften it.

Editorial Correspondence runs heavily to letters asking who makes this and that. Reference to the *Buyers' Guide*, published by ELECTRONICS in mid-June, will save us all a lot of time and trouble.

Possibility Of Error in this column keeps us awake nights. Should one occur we will probably fall back on the phrase overheard in a McGraw-Hill elevator the other day. A company researcher who shall be nameless was heard to remark that he had been "misinformed by a reliable source."

Audax
TRADE MARK

TUNED-RIBBON
reproducers



TUNED-RIBBON Pickup
model *STUDIO - 81*
(actual size — special arm not shown)

• A model for every purpose

ADMIRABLY this revolutionary NEW line by Audax bears out the business maxim:—

"LOOK TO THE LEADER·FOR LEADERSHIP"

Technicians, listening to the incomparable reproduction of TUNED-RIBBON, have been startled at the realism!

The technical side is eye-opening . . . Near-zero mass; linear response to 15 kc.; practical output; point pressure of but 14 grams; jewel point; torsional action eliminated.

Translated into performance . . . clearcut, faithful *fac simile* reproduction that takes you to the very studio where the program originated. Ear-pleasing (there ought to be a word in our language for it) . . . proving anew Audax right to the slogan:—

"The Standard by Which Others Are Judged and Valued"

Yes, Audax TUNED-RIBBON has put something into reproduced music that was not there before . . . let YOUR ears be the final judge.

Send for literature

AUDAK COMPANY

500 Fifth Avenue **New York 18**

CREATORS OF FINE ELECTRO-ACOUSTICAL APPARATUS SINCE 1915

36 TYPES OF . . .

. . . INDUSTRIAL ELECTRON TUBE SOCKETS by AMPHENOL

To insure top performance and long uninterrupted tube life, leading manufacturers of electron tubes cooperated with Amphenol engineers in designing these new Industrial Sockets. With 36 types currently available, and more to come, Amphenol Sockets today are available for practically all electron tubes now in use.

Amphenol Industrial Electron Tube Sockets combine the best of design in terminals, contacts and insulation. Quick-connect screw type terminals simplify testing in original equipment and the replacement of sockets in older equipment. Cloverleaf contacts, an exclusive Amphenol feature, provide four full lines of contact to the tube pins and assure against loss of conductivity under the heavy current loads of industrial applications. Insulation materials have been chosen to provide maximum physical strength, high arc-resistance and reduced carbon tracking. Barriers provide extra safety factors.

These Amphenol Features Spell Top Efficiency

- ★ First to comply with N.E.M.A. and Underwriters' specifications for industrial equipment.
- ★ Rugged insulating barriers prevent flashover and arcing in humid and dusty industrial applications.
- ★ Reversible binding screw terminals simplify wiring and maintenance.
- ★ Cloverleaf contacts . . four full length lines of contact with each tube pin.

See your parts jobber, or write today, for full technical and cost data on Amphenol Industrial Electron Tube Sockets.

AMERICAN PHENOLIC CORPORATION

1830 South 54th Avenue, Chicago 50, Illinois

COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RADIO COMPONENTS • PLASTICS FOR ELECTRONICS

help is forthcoming. That, says our informant, is good but not good enough. He believes the electronic engineers should familiarize themselves with the work being done by other engineers in the plant so that they can voluntarily suggest possible solutions, clinches his argument by insisting that the firm's electronics department is a service department, just as the safety department is a service department. . . . . and who ever heard of research and development people asking safety people for help?

Taxicab Radio System construction permits issued up to July 1 by the FCC totalled 1,400 (10,000 mobile units). As near as we can find out, 217 systems (2,377 mobile units) have been installed by one manufacturer, and another 50 systems have been installed by other companies. Many more have been sold but not delivered.

Figures we've seen on the cost of taxicab radio vary from 67¢ to $1.40 per day, per cab, for a 50-cab fleet. This covers amortization of the cost of the equipment, installation, and maintenance. Dispatcher's time is not included.

Mobile Radio is not without its hazards. A friend of ours who wanted to contact an experimentally-equipped car the other day picked up his telephone and asked for the mobile operator. After considerable delay a feminine voice said, in a conventional manner that made him suspicious: "Number please." So he repeated: "Is this the mobile operator?" Back came the voice: "Yassuh, this is Mobile. . . . . Alabama."

Common Carrier Service on 152 mc for motoring doctors, salesmen and others who must remain in close contact with their offices is about to break out of the experimental into the commercial stage in several cities. Equipment will probably be rented.

Howard Hughes' Radar for commercial airplanes is coming off production lines at the rate of 50 per week, with initial production of 2,000 of the low-cost 16-lb devices planned. First shipments went largely to TWA for use in obstacle-

CROSS TALK

▶**HARTLEY . . .** Hartley's law, that the amount of information that can be transmitted in a given time is proportional to the bandwidth of the circuit, has always seemed an unchallengeable fact of nature. But now comes word that the law is up for revision. We have it from W. G. Tuller, of MIT's Research Laboratory of Electronics, now completing a doctor's thesis on this subject. He, among others including Professor Wiener of MIT and C. R. Shannon of the Bell Labs, has proved that the Hartley rule must take into account noise as well as signal. The old law said that the product of bandwidth and time was a constant for a given amount of information. The revised law says that the bandwidth-time product should be multiplied by ln $(1 + S/N)$ where S/N is the signal-to-noise ratio. In a noise-free circuit, this multiplier becomes infinite, so a finite amount of information can be sent in zero time on any old bandwidth. The practical man knows this just ain't so. The rejoinder is that all circuits do in fact transmit noise, so the multiplier is not infinite. But it's not necessarily unity either, as Hartley implied. One important result of the analysis is that all modulation schemes (a-m, f-m, ptm, and so on) are essentially identical in their ability to transmit information in a given bandwidth with a given signal-to-noise ratio, a fact long suspected. Only apparatus limitations (real though they are) give f-m any noise advantage over that possible from new a-m techniques when both use the same bandwidth. Moreover the theory indicates that none of the modulation methods now used is as effective in combating noise as it might be. There is as yet no published reference on this subject, but several papers are expected in the forthcoming months. Our guess is that the new theory, like many another in the history of physical science, will open new doors in practical technology. As soon as we find a presentation of the theory in engineer's language, we'll print it.

▶**FIDELITY . . .** We commend the article by Harry Olson which appears on page 80 of this issue. Taking a new slant on the question of audience desires, Dr. Olson set up a system for changing fidelity acoustically, thus eliminating many questions rooted in the electrical performance of the system. He concludes that audiences prefer music as played, not doctored, but hastens to add these conclusions are not necessarily at variance with the findings of other investigators, since the methods of measurement are radically different. We take great heart, nonetheless, from this evidence that listeners do prefer truly natural reproduction, even though we have as yet, apparently, no electrical system faithful enough to demonstrate the fact.

•

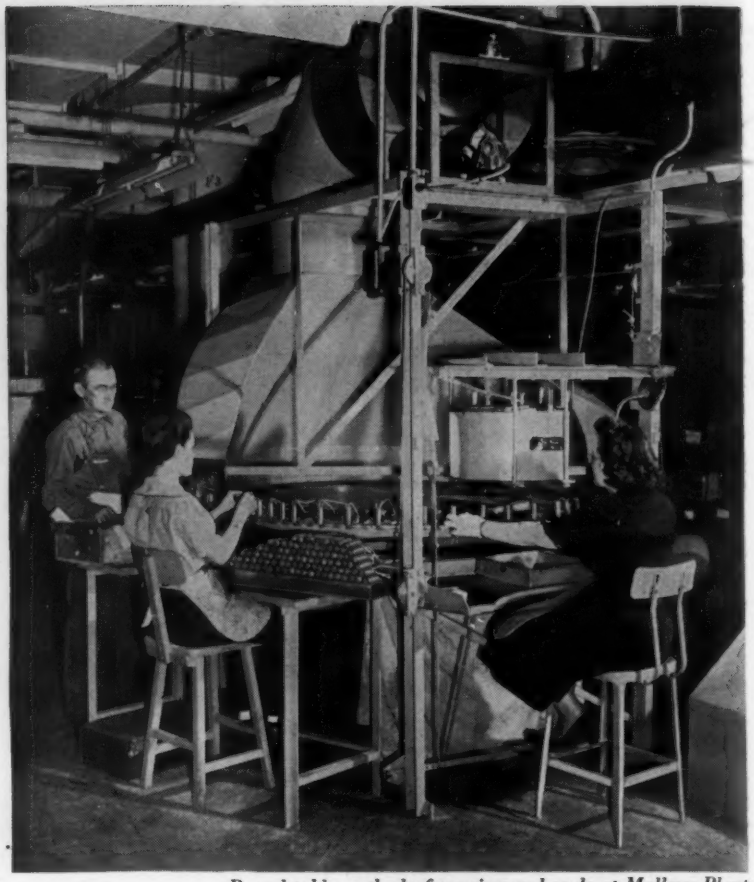
▶**ULTRAFAX . . .** On this page last January we considered the future possibility of facsimile transmission on television channels, pointing out that the television bandwidth is wide enough to handle 108,000 complete facsimile pages per hour. Such is the speed of our industry that we now read, some seven months later, of the Ultrafax system, described by Niles Trammel of NBC testifying before the Senate Commerce committee. Developed by RCA and billed as "television used for communications", the new system is to operate at 1,000,000 words a minute. Each transmitted page is handled as a single frame of a television image and is separately photographed at the receiving end. Mr. Trammel cited this device as evidence that radio broadcasting was fast getting into the printing business, and deserves freedom of expression under the law equal to that enjoyed by the newspapers. Being in the publishing business ourselves, we extend the hand of brotherhood to the broadcasters. But we pale before the cavernous maw of Ultrafax, busily ingesting 60 million words an hour. We have enough trouble getting together 100,000 words, more or less, each month. A big newspaper publishes less than 200,000 words a day. So beware, broadcasters, and get those typewriters oiled. There's big doings ahead.

MALLORY

Cardboard

Tubular Electrolytic

CAPACITORS

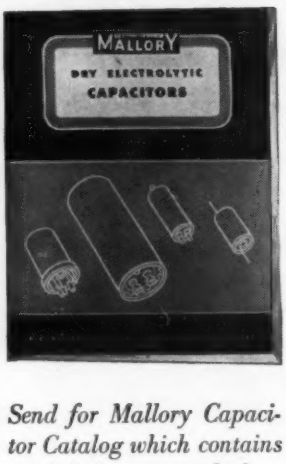


Round table method of pouring end seals at Mallory Plant

We put more into them . . . You get more out of them

DEPENDABLE PERFORMANCE at low cost has won widespread popularity for cardboard tubular electrolytic Capacitors in low priced equipment where operating conditions are not severe. Mallory tubulars are made under the same rigid processing and inspection methods that haved earned for Mallory Capacitors a world wide reputation for highest quality.

The extra inner seal, generous end seals and controlled freedom from contamination in handling provide the extreme reliability for which they are noted. Their long life, their ability to survive high temperatures and heavy ripple currents are due to unique processing operations developed in nearly twenty years of research experience.



Send for Mallory Capacitor Catalog which contains useful data on tubulars and on other Mallory electrolytic Capacitors.

P. R. MALLORY & CO. Inc.

MALLORY CAPACITORS

(ELECTROLYTIC, OIL and WAX)

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Range Preference
FOR SPEECH AND MUSIC

Live talent played popular music, and people familiar and unfamiliar to an audience talked. An acoustical filter consisting of movable panels was introduced to cut off response at 5,000 cycles. Results are presented here

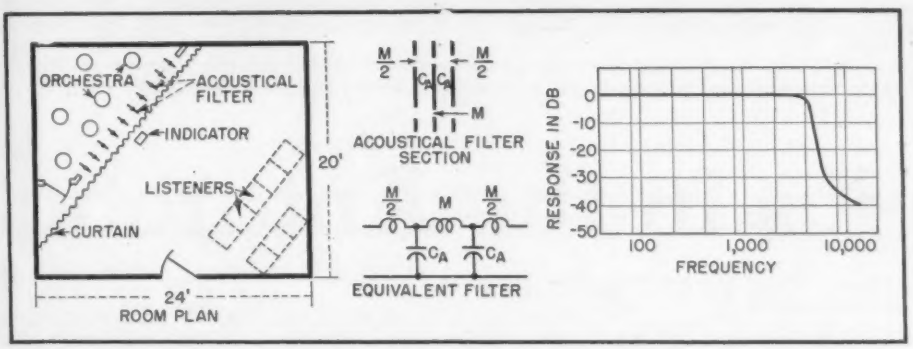


FIG. 1—Plan view of the room in which the tests were conducted, and a sectional view of the acoustical filter. Electrical equivalent of the filter, and a graph showing response-frequency characteristic, are also shown (Above)

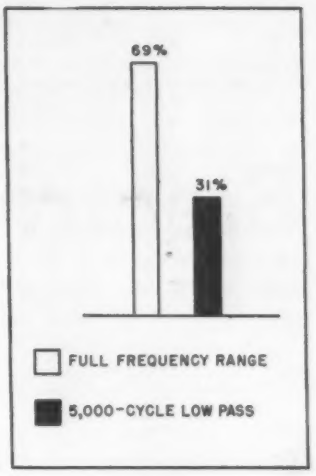


FIG. 2—Frequency-range preference of 1,000 listeners on popular music (Right)

bass, drums and traps. Popular music was used for a major portion of the tests. The orchestra was balanced for the most pleasing condition. The balance was checked by competent musical directors.

The listeners were selected from random visitors to the Laboratories. They were brought into the room and told that there was a source of music behind the curtain which would be rendered under two conditions, namely, *A* and *B* as depicted on the indicator, and that the two conditions would change every 15 seconds. The listeners were asked to vote for the condition which they preferred on a ballot provided for this purpose.

Results

Over 1,000 listeners participated in the tests. The aggregate results of all the musical tests are shown in Fig. 2. It will be seen that there is a preponderant preference for the full frequency range.

Tests were made on speech, where the listeners were familiar with the speaker's voice. Under these conditions, the listeners felt that there was a detrimental change in the voice when the frequency range was restricted to the 5,000-cycle low-pass transmission.

In tests in which the listeners were not familiar with the speaker's voice, the majority voted for the full range. The comments on the restricted range were as follows: "muffled", "muddy", "mushy", "lacking in intimacy", "pushed back", "not as intelligible".

Conclusion

The results of the test do not coincide with most of the results obtained on monaural reproduced sound. In the case of reproduced sound, there appears to be a preponderant preference for a restricted frequency range.

The results of the test reported here appear to rule out the first two reasons for the preference of a restricted frequency range in reproduced sound outlined in the introduction, namely: (A) That the average listener after years of listening to the radio and phonograph has become conditioned to a restricted frequency range and feels that this is the natural state of affairs. (B) That musical instruments are not properly designed and would be more pleasing and acceptable if the production of fundamentals and overtones in the high-frequency range were suppressed.

There remains one other reason for a preference of a restricted frequency range in reproduced sound, namely, the distortions (C) outlined in the introduction.

Frequency

By HARRY F. OLSON
RCA Laboratories
Princeton, N. J.

Movable panels between audience and talent permitted response to be cut off at 5,000 cycles. Panels were concealed by a curtain during actual tests

SUBJECTIVE TESTS of frequency range preference of reproduced sound have been made by various organizations from time to time. These tests appear to indicate that the average listener prefers a restricted frequency range in monaural reproduced speech and music.

There are three possible reasons for the results of these tests, as follows: (A) That the average listener after years of listening to the radio and phonograph has become conditioned to a restricted frequency range and feels that this is the natural state of affairs. (B) That musical instruments are not properly designed and would be more pleasing and acceptable if the production of fundamentals and overtones in the high-frequency range were suppressed. (C) That the distortions and deviations from true reproduction of the original sound are less objectionable with a restricted frequency range.

Distortions

The distortions and deviations from true reproduction of the original sound are as follows:

(1) Amplitude distortion
(2) Nonlinear distortion
(3) Spatial distribution
  (a) Relatively small source
  (b) Separated sources in two-way loudspeaker system
  (c) Nonuniform directional pattern with respect to frequency
(4) Single channel system
(5) Phase distortion
(6) Transient distortion
(7) Microphone placement and balance
(8) Acoustics of two rooms, the pickup studio and the listening room
(9) Limited dynamic range
(10) Difference in level of the original and reproduced sound
(11) Noise

To obtain a better understanding of the reason for the preference of a restricted frequency range in reproduced sound, a fundamental all-acoustic test of frequency range preference was made. A small orchestra was used for the source of sound in this test. An acoustical filter was placed between the orchestra and the listeners and arranged so that the filter could be turned in or out.

Room and Filter

The floor plan of the room and the general arrangement of the test is shown in Fig. 1. The room was designed to be the acoustical equivalent of an average living room and is 24 feet long, 20 feet wide and 9½ feet high. It is partially finished in acoustical plaster backed by two inches of Rockwool. A wainscoat extends up four feet from the floor. Drapes are also used to cover a part of the wall surface.

The reverberation - time frequency characteristic approximates that of a typical living room of this size in a home or apartment. The average ambient noise level in the room without the orchestra or listeners is 30 decibels.

The acoustical filter used in the tests consisted of two sections. A sectional view of the acoustical network, the electrical equivalent, and response characteristics are shown.

The filter was made in the form of elements one foot wide by eight feet in length. These elements were pivoted at the top and bottom so that the filter could be placed in or out of operation by turning the entire group of elements by means of a lever. Overlapping strips backed with felt gaskets, together with weights, insured a soundproof joint with the filter in the operating position.

The response-frequency characteristic of the filter approximates very good commercial radio or phonograph reproduction in the high-frequency range. A cloth curtain was used to cover the filters so that listeners could not see what transpired behind the curtain. The loss in response introduced by the cloth curtain is negligible. The particular condition, that is, the full frequency range or the 5,000-cycle low-pass transmission, was depicted on a frequency indicator.

Test Procedure

The orchestra used in the tests was composed of six semi-professional musicians. The following instruments were used: piano, trumpet, violin, clarinet, contra-

Type GPN (Ground Pulse Navigation) airport area surveillance unit on air strip at Little America, with ships moored in Bay of Whales in background. This radar unit was used exclusively for keeping track of all aircraft within a 30-mile range

Electronics in the Antarctic

By HENRY C. BAILEY

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On duty with staff of Task Force Sixty-Eight

ELECTRONICS as used during the latest U. S. Navy Antarctic Expedition served three good purposes: it substantially reduced the magnitude and number of hazards commonly associated with the venturing of numbers of ships, aircraft, and personnel into such wild, bitter, unexplored territory; it permitted certain operations hitherto impossible; and the use of standard and experimental electronic equipment under the conditions of the expedition gave information of considerable value in future design and operation of that and other equipment.

The purpose of this article is to describe as completely as possible some of the operational and experimental uses to which electronic equipment was put, while still remaining within the restrictions imposed by governmental security regulations.

Radar in Ice

Radar did not find a new use during this operation, but old uses were put to critical trial. It was used very successfully in detecting icebergs and growlers, in finding openings in the ice pack through which columns of thin-skinned vessels had to break their way, and in conning vessels through concentrations of huge icebergs that almost defy imagination of bulk, fearful aspect, and number.

Surface search equipment was used successfully as ground-controlled approach equipment on certain vessels. At close ranges planes could be vectored into an ice-free area for landing. One vessel in a dense fog successfully vectored a plane, taxiing on the surface, four miles through ice-flecked water. Solid indications were obtained from the plane as well as from all pieces of ice large enough to damage the plane's very thin hull. The sea at that time was quiet and the smallest pieces of ice showed up clearly on the indicator.

Air search equipments proved invaluable to seaplane tenders in enabling patrol planes to return to their vessels after long flights, and added to the utility of small vessels used as emergency seadromes. Usually planes on completing long flights had to let down through overcast, for which positions had to be furnished. Radar fixes were provided by the air search equipments. Aircraft were usually picked up on return flights at about 80 miles and vectored in.

Under conditions where the sun could not be used for compass check after outgoing planes were airborne, radar provided the navigators with fixes for checking course and ground speed. In all cases, air search equipment definitely reduced hazards attending air operations in areas where navigation was difficult.

Fire control radar equipment on two vessels was used in observing wind speed and direction at high altitudes. Corner reflectors borne aloft by aerological balloons were tracked with these equipments out to ranges near 55,000 yards, with an average range of about 40,000

Standard Navy shipboard and aircraft communications equipment installed at temporary base camp on Antarctic ice

Effectiveness of electronic equipment on recent U. S. Navy expedition, including radar and sonar for ships among icebergs, radar and GCA for air navigation, radio for communication, broadcasting, teletype, and radiophoto, and an airborne magnetometer for aerial surveying

yards to signal fadeout. Valuable wind information was obtained in this manner, which substantially reinforced the framework of weather information so vital to operations of this nature. Because of weather conditions there would have been no other way to obtain this information.

A relatively new, very high definition radar proved of great value to the icebreaker carrying it in working in the ice, in detecting small targets that other equipments missed, and in gaining greater detail in targets of all sorts. During one phase of the operation photographs made of the plan-position indicator of this equipment enabled hydrographers to complete a useful and accurate coastal survey of a group of islands which at that time were shrouded in fog such that aerial photography was impossible.

Three- and ten-centimeter radars proved very dependable in reducing navigational hazards associated with icebergs and other dangerous masses. With such radars, icebergs over 200 feet high were reliably detected at more than 40,000 yards, smaller icebergs at an average of 35,000 to 40,000 yards, growlers of various sizes at an average of 7,000 to 8,000 yards, and pack ice, floating loose pack, and brash at up to 13,000 yards. Antenna height was about 100 feet, and equipment was in design-standard operation.

In most cases a sizable portion of the top of the berg was projecting into the line of sight before the tilted or rounded peak returned a signal sweeping low enough to intercept the radar antenna. On very clear days the peaks of the largest icebergs, reflecting much light from all angles, frequently were visible through glasses before the returning radar signal swept low enough to be detected.

Air search equipment proved inferior to microwave surface search equipments for detecting ice. Ice was detected, but at generally shorter ranges. The relatively poor definition inherent in air search was a marked disadvantage in its use against dangerous ice masses, although the prime function of the equipment, that of detecting and determining range and azimuth of aircraft, remained just as important and just as effective in high latitudes as anywhere else.

Sea return, the radar indicator clutter caused by return signals from the surface of the sea, proved to be a limiting factor in the detection of small icebergs and growlers. Following an inverse fourth-power relationship with range, in rough seas it extended out sometimes to the maximum range at which small ice masses, still large enough to damage the vessel, could be detected. In this way a hazard was introduced, for growlers not detected before they came within the radius of sea return conceivably could not be detected by radar at all. Actually, however, all ice masses dangerous to navigation were detected in time to be avoided. Reduction of the gain of the receiver, and judicious use of such controls as fast time constant and time-varied gain proved of some value in circumventing these difficulties.

Meteorological conditions such as fog, rain, snow, and weather fronts were factors worth considering. It is known that these effects attenuate the radiated and reflected energy, the degree varying in individual cases. No serious handicap was apparent, but the lack of finite evidence of such handicap should not deter from normal, commonsense precautions. On occasions, icebergs were detected at twenty or more miles through very dense snowstorms; but those same snowstorms completely obscured all targets in the immediate vicinity of the vessel.

No equipment failed utterly because of weather conditions. Difficulties were had with high winds blowing on rotating antennas and placing unusual loads on their drive motors. One case was reported where the high winds forced water into a drive motor and drowned it. These difficulties were met by alert maintenance personnel. For the most part the materiel held up well under the conditions encountered by the task force and is a

credit to the painstaking effort of designers and manufacturers throughout the country.

Sonar in Ice

Sonar found use as a substantial aid in navigation of icewater. Water temperatures in the ice regions consistently lay near 32 degrees Fahrenheit, dropping as low as 29 degrees in some areas. Great uniformity of water temperatures and linear temperature distribution patterns made conditions for sound propagation in Antarctic waters excellent beyond expectations. There were exceptions to this, but in a characteristic area the predominant pattern showed an isothermal surface layer between 60 and 80 feet in depth, a slight negative gradient between 80 and 300 feet, and a slight positive gradient extending below 300 feet. Deviation from strictly isothermal conditions was seldom in excess of a few degrees.

The only abnormality in operation of the equipment was associated with changes in water temperature affecting the resonant frequencies of magnetostriction sound projectors, necessitating minor adjustments of driver frequencies by maintenance personnel. This in no way constituted a difficulty, for the tuning range of the drivers is invariably broad enough to include any conceivable change in resonance characteristics of the projectors.

Sonar became of great value in detecting ice targets during conditions of reduced visibility. Vessels carrying horizontal echo-ranging equipment used it in conjunction with radar with excellent results. Sonar detected ice masses too small to be detected by radar through sea return, even when swells as high as six and eight feet were encountered.

Sonar was not so trustworthy when storms and heavy seas were encountered. Under these sea conditions the effectiveness of the equipment was reduced because of water noises and rolling of the ships. One destroyer rolled 50 degrees under these conditions, and an ice-breaker topped that.

During moderately calm periods, and when water conditions were at their best, sonar could be depended on to detect icebergs at 3,000 to 4,000 yards, growlers at 1,500 to 2,000 yards, and pack ice or brash at up to 2,000 yards.

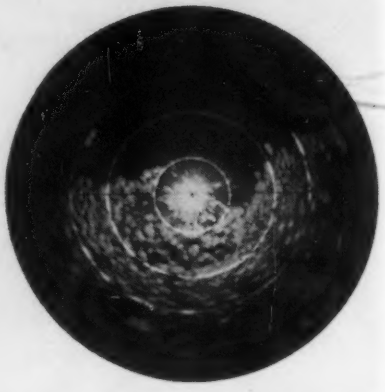
Ranges checked within 20 to 30 yards of radar ranges taken simultaneously, with a percentage rather than fixed error. The velocity of sound through salt water varying with temperature possibly accounts for the discrepancy. Bearings obtained checked usually within two degrees of the radar bearings. It must be remembered, however, that the target definition of sonar is not to be compared with that of surface search radar, so greater errors in azimuth determination may be expected with the sonar equipment.

One vessel conducted a few experiments to determine the utility of echo depth-sounding equipment for studying the temperature and other refractive layers commonly responsible for reverberations. This study bears relationship to the study of marine life and is also of military value to the Navy. Refractive layers were found at varying depths even in areas where the temperature distribution pattern is substantially vertical or linear. This tends to indicate, especially in the light of oceanographic studies of planktonic forms of animal life in these regions, that it was layers of concentrations of these microscopic organisms that comprised the refractive media which gave return signals. Knowledge of the behaviour of any such refractive area is of great interest to designers of Navy echo-ranging equipment, especially that used in submarine warfare.

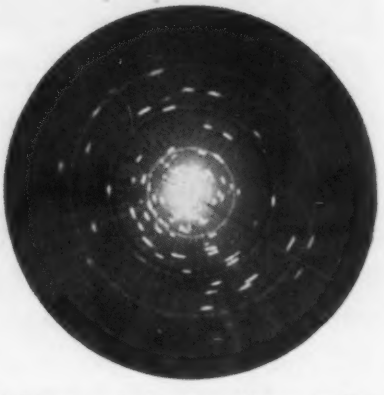
Sonar also found a use in the study of marine life. The ability of underwater sound equipment to detect whales was noted, and future operations of this nature may provide much information on habits of whales.

Radio Teletype

The radio teletype system established between the USS Mount Olympus, at or near the Bay of Whales, and Washington, D. C. was used extensively in passing high-priority radio traffic to Washington. Approximately half a million words of press copy were transmitted in this manner from Antarctica to Washington during the course of the operation.



Antarctic ice pack as seen on ppi screen of 10-cm radar using 4-mile scale. Though ice rose only few feet out of water at this point, it was detected at 10,000 yards



Icebergs and growlers (dense icebergs floating mostly under water) as seen with 10-cm radar using 20-mile scale. Some of the bergs are up to 300 feet high and 1,000 feet long. Sea return is moderate

Radio Washington had little difficulty in obtaining perfect copy for an average of over thirteen hours per day. Rhombic antennas and an elaborate diversity receiving system were used at the Washington end, the antennas trained exactly on Little America. The flagship was using standard type 19 teletypewriter tables operating through Navy type FSA Western Electric frequency shift keyers into one-kilowatt transmitters connected to vertical single-wire antennas in a characteristic Navy installation. Frequencies in the 12, 17, and 21 mc bands were found the most effective.

In spite of the fact that Radio Washington had rhombic transmitting antennas beamed on Antarctica, reception by the Mount Olympus was severely limited by high interference level. Local transmit-

Radar and radio antennas on USS Pine Island, one of the ships taking part in recent U. S. Navy Antarctic Expedition. Despite large size of parabolic reflector, the P-band air search radar on this ship did not give very good definition on ice targets

ters, being used on high power to reach the remotely-located Eastern and Western Task Group commanders, interfered badly with reception from Washington. Standard shipboard receiving equipment was used, operated through model FRA RCA-manufactured frequency shift converters; receiving antennas were the usual shipboard single-wire verticals.

Directional antennas were erected at the camp at Little America but time limitations prevented their being used operationally; they were used for tests only, a few messages being transmitted manually. There is little doubt that had the same radio teletype equipment been used with these antennas both transmission and reception would have been vastly improved.

Radio Photographs

The Mount Olympus maintained radiophoto circuits with Radio Washington and Radio San Francisco throughout the operation. A daily schedule was maintained commencing at 0600 GCT and lasting usually three to four hours, that time found the most dependable.

Frequencies in the 9 and 13 mc bands were used for transmitting and the 13 mc band for receiving. Other frequencies were available, but these were found to provide the best circuit conditions during the times chosen for schedules.

An Acme type CNP telephoto transceiver was used with a model FSD Press Wireless frequency-shift keyer. One kilowatt of r-f power and a single-wire vertical radiator were used in the transmissions. This equipment was monitored with a standard Navy shipboard receiver, an oscilloscope, and audio signal generator.

The urgency of other communications and the volume of outgoing picture traffic prevented much experimenting on reception by the ship, and only a few pictures were received. Two pictures of very good quality were received by the ship while moored at Little America.

At best the results in general could be considered fair. The majority of pictures transmitted were fair to good, with a few of excellent quality. About 190 7-inch by 9-inch pictures were transmitted to the Office of Public Information. To provide these, many pictures were transmitted more than once, either on the same schedule or on following schedules. Altogether about 390 transmissions were involved.

The long distance separating Antarctica and continental United States and the need for directional antennas were the chief reasons why the results were not better. Radiophoto requires somewhat better signal-to-noise ratios than manual telegraphy or radio teletype, and increased transmitter power or the benefit of directional antennas would have been the only means of increasing the volume or bettering the quality of pictures transmitted.

Radio Broadcasting From the Mount Olympus

About two weeks before the Task Force sailed from U. S. ports the operation was declassified and it was learned that radio networks would provide representatives to participate in broadcast work.

The Mount Olympus was chosen to do the transmitting. At that time the only transmitters installed on board suitable for broadcast work were two Westinghouse 350-watt Navy model TBM-7 equipments. Obviously these transmitters would not serve the desired purpose because of their low power and the 9,000 statute miles separating Long Island from Antarctica. Accordingly a Collins, Navy model TDH-4, 2,500-watt phone transmitter was provided for installation.

The TDH-4 equipment was designed for shore use where 230-volt, 3-phase power and an abundance of space are provided. Special transformers were provided initially to make available the necessary voltage, but getting the bulky units of the equipment in place on board and erecting suitable antennas proved difficult. One model TBM-7 transmitter was removed and set aside in the transmitter

room to make more space available. Doors were burned out where they interfered with passage of the larger units. Because the pi-network output of the power amplifier was designed to work into a moderately low impedance, special transmission lines were run topside through antenna trunks to a home-made antenna change switch and from there to either of two doublet antennas cut to operate in the 17 and 19 mc bands, respectively. Since the new transmitter was received when the ship arrived at Panama, this installation work was done at sea.

While the TDH-4 was being installed, the TBM-7 remaining in operation was being used successfully. As the ship neared the halfway point between Panama and the Antarctic Circle, installation was completed on the TDH-4 and it was placed on the air.

Frequencies in the 9, 12, 15, 17 and 19 mc bands were allotted. Of these, only the latter two were used extensively. It is believed that had higher frequencies been available they should have proved still more satisfactory.

The War Command room was used as a studio. At best it was not too good, as an expansion joint in the superstructure traversed this space and squeaked as the ship rolled. A ventilation blower in an adjacent space contributed to the noise. Acoustics were somewhat improved by hanging curtains around the studio room. It was in this room that control and monitoring equipment, RCA broadcast microphones, an RCA 4-position mixer and line amplifier with a volume unit meter, General Electric wire recorders, and standard Navy shipboard receivers were installed. All programs were recorded on the wire recorders as they were transmitted.

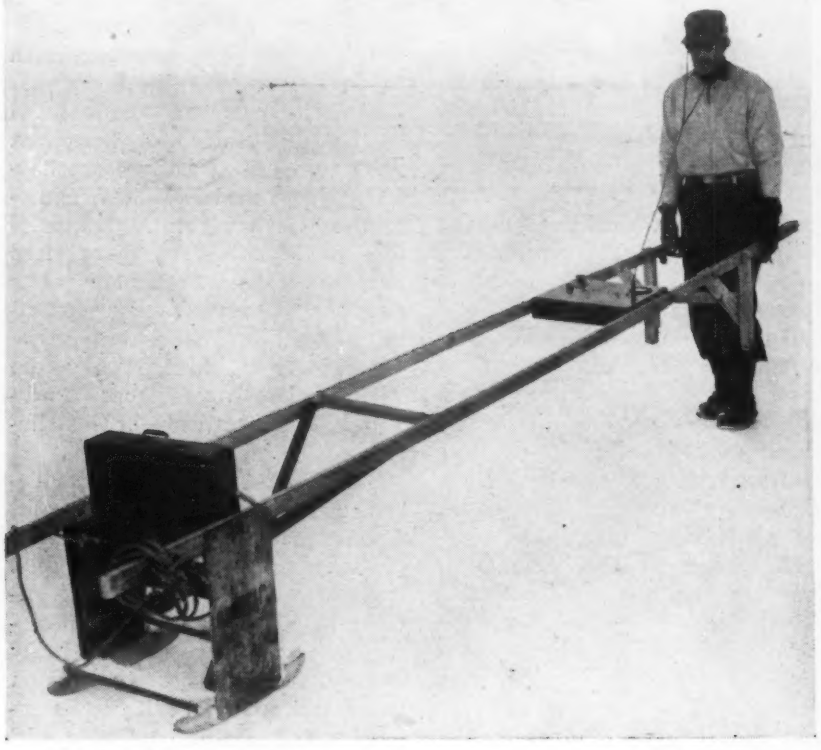
Schedules were held with RCA Communications and Press Wireless, Inc., twice daily at 1230 and 2330 GCT, one-half hour earlier than the morning and evening news roundups on the networks. On these schedules broadcast times were established and cues were arranged.

Four major networks were represented. Most of the programs were live news bulletins, with an occasional interview of some personality on board. There was one long program at Christmas when personnel on board the ship talked with their families in the U. S. Altogether about seventy seven successful programs were transmitted and used by the networks mentioned. Sixteen others were unsuccessful due to radio wave propagation conditions.

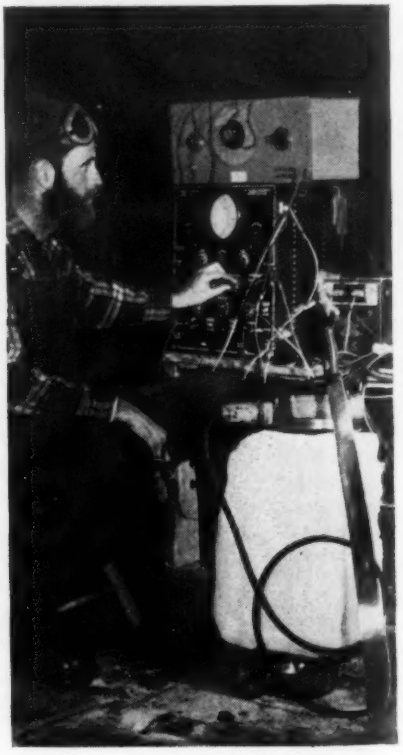
Communication Facilities at Little America

The original plan for air operations with the two-engine patrol planes called for landings, take-offs, and local flights of limited radius being controlled from the air strip. Longer flights were to be controlled by the Mount Olympus, moored to the ice within view of the landing area. Ice conditions forced a change in those plans, however, as the ship was forced to retire to the vicinity of Scott Island, leaving the base camp to hold its own.

To serve as a control tower at the air strip and to house the equipment and operators, a Quonset hut was erected. This building also served as an airborne electronics and general plane maintenance shop in which were installed battery-powered, dynamotor-operated aircraft type transmitters and receivers for communication with the planes, the ships moored to the ice,



This modification of a commercial electronic metal locator located metallic objects in ice at depths as great as 25 feet



Equipment for measuring velocity of sound through ice

and the Emergency Base. All transmitting and receiving antennas were erected in the necessarily congested area, but the equipment operated satisfactorily nevertheless.

Later, as time allowed, a Navy model YR radio beacon, a 400-watt intermediate-frequency transmitter, and better intra-camp communication equipment were installed and the aircraft type radio receivers replaced by a-c operated receivers. Other improvements were made, most notably in power supply facilities, which improved operations by reducing radio interference. The camp being located as it was on dry snow and ice, with no physical earth ground, local interference such as ignition and commutator noise became a factor of grave concern. There being no way to shield equipment from the sources of interference, it was mandatory that the sources themselves be eliminated. This was done by reshuffling the power equipment. A two-kilowatt d-c motor-generator set was replaced by a bank of storage batteries floated across an a-c rectifier charger, and most dynamotor-powered equipment was replaced with a-c equipment.

The ice and snow underfoot was several hundred feet deep and no means were available to drill clear through to the seawater below. Even had a hole been drilled and a suitable low-resistance ground cable lowered, it is doubtful that interference conditions would have been noticeably improved. Due note has been made of this situation. Any future operations in this area will be provided with means for drilling many holes through the ice in an effort to raise the ground plane.

Before the flagship was forced to depart, the USS Philippine Sea, then 650 miles to the north, discharged the six planes that were to operate in the area. Good communications were had between the Mount Olympus and the planes on their flight to the airstrip; voice communication in the 4 mc band was excellent throughout; the automatic direction finders on the planes operated nicely in the 400 kc band with signals from a two-kilowatt transmitter.

Communications with planes on long flights were vested in the Emergency Base radio station. This camp was intended to be of a more permanent nature since there were possibilities that it would be occupied all winter. It comprised a double Quonset hut located about two miles from the temporary base camp at the airstrip and equipped with voice and c-w transmitters necessary to enable it to perform its function. Power was supplied by a diesel-driven a-c motor-generator set. This Quonset was well insulated from the weather and sealed against sifting snow.

Rhombic antennas for transmitting and receiving were erected at this site and directed toward Washington, D. C. In addition, Marconi L and T transmitting antennas and miscellaneous receiving Marconi and doublet antennas were installed.

Telegraph c-w communications with planes on extended flights out 700 to 800 miles to the South Pole and beyond were good at all times. Tests with Radio Washington, using the rhombics, proved highly successful on the 8, 12 and 16 mc bands.

The absence of a physical earth ground presented difficulties here as at the temporary camp. A wire counterpoise, connections to the power plant and connections through a tunnel to the old Little America buildings, and the provisions for use of only a-c operated equipment eliminated these difficulties. The 96-foot length of the Quonset hut provided adequate counterpoise for high-frequency transmissions.

Ice and snow in Antarctica is so dry that an antenna stretched out on the ice works beautifully. The snow is fine and grainy in texture and perfectly dry, unlike that found in the Arctic.

This snow does not pack down very well, and hauling of heavy equipment was seriously complicated by that fact. Equipment was loaded on steel go-devil sleds weighing about two and a half tons and fitted with runners, and drawn by D-6 Caterpillar tractors. On the bay ice these tractors worked nicely in the snow without any modification. Up on the barrier the tracks had to be fitted with oak extensions which provided additional traction and prevented the tractor from digging down into the deep snow. To draw the sleds up the steep slope between the bay ice and the barrier, a cable railway system was used whereby the tractor or tractors in use ran down the slope or on level ice to draw the sled upward.

Ground-Controlled Approach

The objectives in transporting bulky MPN-1A and GPN-2 GCA equipment to Antartica and setting it up at Little America were threefold: (a) to provide facilities for planes to land at Little America under conditions of reduced visibility; (b) to augment communication facilities and act as auxiliary to airstrip control; (c) to determine the practicability of GCA under the difficult conditions for movement, installation, and operation of the equipment.

The completed installation of the GPN equipment accomplished the first two objectives. Although the MPN was not used operationally, still it was installed and tested successfully, satisfying the third objective.

Temperatures varied constantly between 26 degrees below and 29 degrees above zero Fahrenheit. One blizzard struck, bringing temperatures around 14 degrees and winds up to 45 knots.

Problems in installation arose by the dozens. Initially it was discovered that the 26,500-pound prime mover for the MPN equipment, when removed from the ship at the edge of the bay ice, not only could not move under its own power in the 15-foot thick snow and ice, but required two D-6 tractors to tow it. The prime mover for the GPN equipment was similarly immobilized. These problems were circumvented by lifting the radar shelter of the GPN off the six-by-six truck bed, and by placing skids under the MPN trailer and towing it by tractor. In each case the associated prime mover was useless. The GPN shelter was towed on its own skids.

The heavy diesel generators presented similar problems. The GPN generator was equipped with heavy metal skids before leaving the ship. The MPN generator truck, being useless as a prime mover, had to be left on board, so the truck bed with generators attached was lifted off

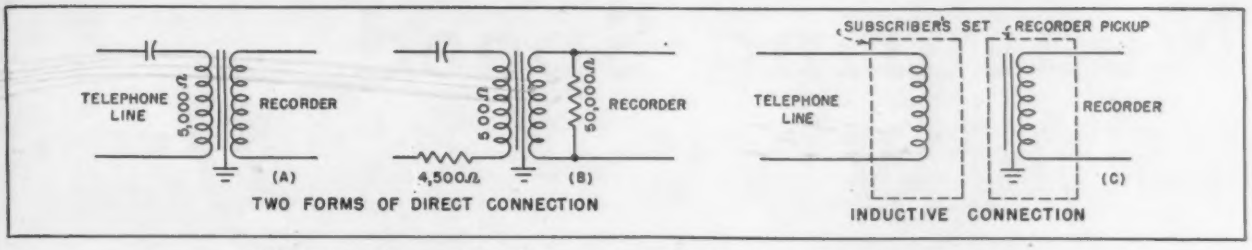


FIG. 1—Recorder can be either connected directly or by induction to telephone

Telephone Recording

Electronic dictating machines can be used to record important telephone conversations. Either direct or induction connection to the line is suitable. Design considerations are given

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LEGALITIES

Use of telephone recorders is now permitted by FCC for legitimate activities as described in Docket No. 6787. This change in regulations governing recording or monitoring telephone conversations has been made because of the utility of permanent documentation of telephone conversation

Personal privacy of telephone conversations will be protected by the use of a distinctive tone (exact nature of which had not been decided upon at press time) when a recorder on the line is operating. Telephone companies will provide and maintain the tone generator

APPLICATIONS

Monitoring message telephoned by contract officers, lawyers, public relations executives, doctors, others whose conversations warrant exact transcription

Automatic recording of messages in absence of person called

Transacting business by telephone such as recording accumulated orders at night over long-distance toll circuits from branch offices, permanently recording telephone orders and thus eliminating need for written confirming orders, telephone dictation from field to home office

Recording fire alarms, calls to police, dispatching instructions of public utilities including railroads and power companies, military commands

TELEPHONE lines carry not only speech signals, but also interfering noise, ringing and other operating voltages. Any connection to a recording circuit should eliminate interference between the telephone pair and ground, provide isolation for direct current, and should not affect or be affected by the operating voltages nor should appreciably load the telephone line.

A typical direct connection is shown in Fig. 1A. The capacitor provides d-c isolation; the transformer blocks longitudinal current (produced by voltage between the telephone pair and ground). Transformer input impedance should be sufficiently high not to appreciably load the line. If the transformer input impedance is low, for example 500 ohms, a series resistor added in the primary circuit, 4,500 ohms in Fig. 1B, prevents loading.

Although speech levels to be expected from a telephone line vary widely, signals available with the direct connection range from +10 db (where 0 db equals 6 milliwatts) for peak levels to −40 db, with good local voice levels averaging around 0 db but with many between −10 and −15 db. Regardless of the high standards at which telephone lines are maintained, wide ranges in speech levels are to be expected because of conditions beyond control of telephone engineers. The recording equipment must, therefore, be designed to record satisfactorily a 40-db range, although the extreme range might be as great as 60 db. To keep the recording level within the range of the recording medium, automatic control circuits should be incorporated in the recorder.

Inductive Pickup

With the inductive connection, shown in Fig. 1C, the telephone terminal equipment forms one winding of a transformer and the recorder pickup is the other. The pickup is formed into a flat unit that can be placed under the subscriber's set. The transformer so formed has low coupling between primary and secondary because of the relatively large spacing. The inductive pickup should be electrostatically shielded to eliminate effects of undesirable fields in the vicinity. From 40 to 60 db are lost in this form of coupling, so the recorder amplifier must have greater gain than for the direct connection. Hum-bucking arrangements can be added to neutralize fields from local motors and transformers, but because such fields are neither constant in magnitude nor direction, complete cancellation is difficult.

Either method of connection is satisfactory, and now that recording telephone conversations has been made legal many applications for this technique will be realized.

and placed on a go-devil sled which could be towed by a tractor.

Both spare parts trucks, one for each major unit, were left on board ship. Only those parts necessary for operation were brought ashore.

The MPN being so heavy and difficult to move, and in light of the fact that weather conditions made unnecessary the precision features of the MPN, it was decided to install the GPN first and place it in operation. Accordingly, the GPN was placed on 3-inch by 8-inch wood timbers laid on level snow and work of assembly and preparation was begun. Spare parts were brought up by sled from the ship. The generator was hauled to a convenient position about nine feet from the door end of the shelter and a tarpaulin was secured between the two so the door to the shelter would open on a place protected from the wind. A 16-foot-square tent was pitched in the immediate vicinity for housing the GPN spare parts and auxiliary radio equipment. It was also used for living quarters.

Throughout the flight operations, the performance of the GPN equipment was satisfactory. Whenever possible, planes in local flights were controlled by this equipment. With its associated communication equipment it was often called on to act as control tower, which it did nicely.

After the GPN installation was well under way, installation of the heavier MPN was begun. Erection of the MPN search and elevation antennas and elevation antenna housing was completed in cold, windy weather. Because of the time element and the prospective brevity of operational usage the heavy radome for the search antenna was not installed. No technical or mechanical difficulties were experienced in the installation, but the wind and weather reduced the efficiency of maintenance personnel to a low point. Many of the operations had to be performed without gloves, and work could be continued for only a few minutes at a time.

All components worked perfectly when the equipment was placed in operation and power applied. Tests made to determine its efficiency under adverse weather conditions proved quite satisfactory.

The time factor entered into the proceedings again, however, and made it necessary that the equipment be dismantled and transferred back to the ship. The GPN was still operating nicely and could perform all the vital functions. Accordingly, work was started—and halted three hours later by the blizzard.

Altogether a great deal of information was gained through the installation, test, and operation of this equipment at Little America. Although the main unit of the GCA system, the MPN, was not used operationally, the main objectives of the operation were accomplished.

Airborne magnetometer used in surveying portions of Antarctic continent

The Magnetometer

The initial purpose behind the provisions for use of the airborne magnetometer during this operation was to obtain magnetic profiles along the tracks flown by the photo-reconnaissance planes operating from Little America. Properly interpreted, these profiles would give information on the geological formations in the earth's crust, and in favorable locations disclose topographic features buried under ice and snow and trace major geologic trends and structures. Used in this way a valuable supplement to the aerial photography of significant parts of the Antarctic continent would be provided.

To accomplish this the U. S. Geological Survey and the Naval Ordnance Laboratory cooperated to provide personnel and equipment to participate in the operation.

The equipment used was the Magnetic Airborne Detector developed by the Naval Ordnance Laboratory and used by the Navy in antisubmarine warfare, modified by the Naval Ordnance Laboratory, the U. S. Geological Survey and the Office of Petroleum Reserves to allow its use as a geophysical surveying instrument.

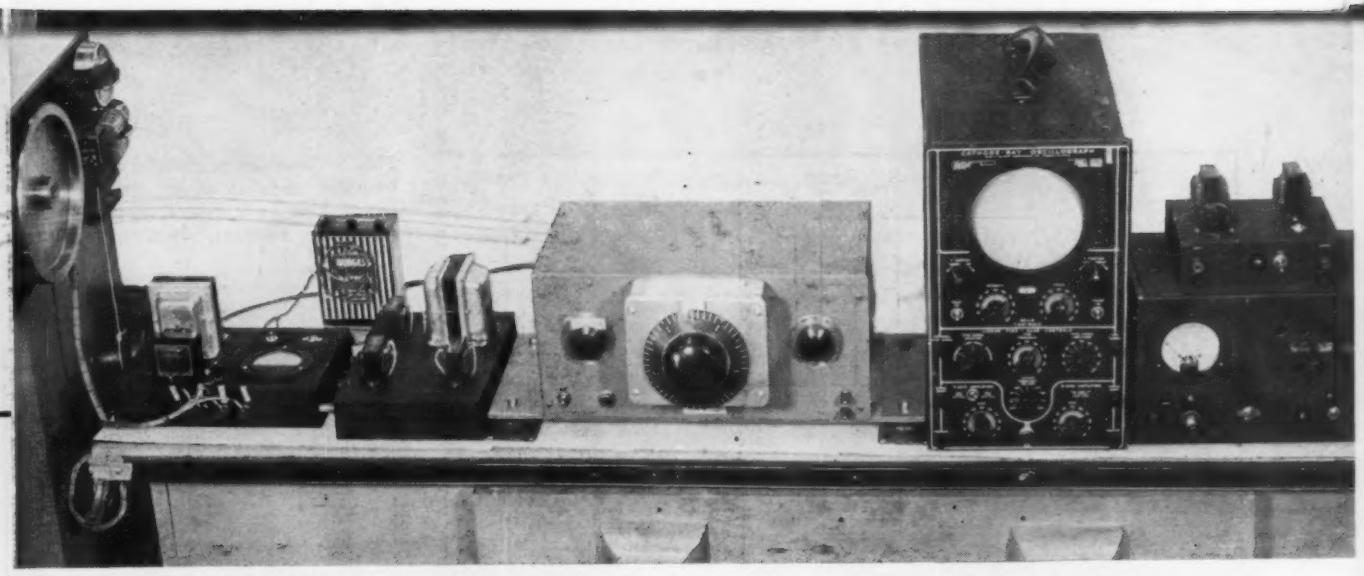
As modified, the magnetometer measures electronically the fluctuations in the terrestrial magnetic field intensity caused by the variations in magnetic properties of different materials in the earth's crust, and continuously records them on a paper chart as the plane moves on.

Two of the planes brought to Scott Island by the Philippine Sea were equipped with the necessary frames and supports to carry the magnetometer. Unfortunately, because of operational difficulties and weight limitations the racks had to be removed before the planes could take the air; because of curtailment of flight operations at Little America it was not until the last five days of the ice reconnaissance that makeshift racks could be installed.

Considering the prospective brevity of the operations, the objective in the use of the magnetometer became one of investigation of the usefulness of the equipment in the Antartic area. To accomplish that, magnetic profiles were made of well-known terrain so that their utility could be evaluated.

Four flights were started. The first was a test hop; the fourth was unsuccessful due to engine failure. The two remaining flights, of 4½ hours duration each, were highly successful.

As a result of the flights, previously-made suppositions as to the material content and the topographic aspects of the areas traversed were in some cases confirmed and in others disproved; whether or not previously suggested, the material composition of the crust along the plane's tracks was determined. The coastline, if you can designate as such the place where eternally ice-covered land meets eternally ice-covered sea, was delineated in the path of the plane.



Laboratory setup for measuring high-speed rotation consists of (from left to right) exciter and line matching unit for the tachometer, audio mixer, audio oscillator, cathode-ray oscilloscope, and full-wave rectifier and wideband amplifier

of the quill served as the generator armature, no mechanical or electrical connection being made to the quill. The tachometer is accurately located in place by dowel pins, making removal easy; it is unnecessary to remove the tachometer when changing the belt.

With reference to the two fixed poles of the tachometer, the flat sides of the quill represent wider air gaps than the rounded sides. The magnetic circuit is roughly U shaped, with a coil on each of the two opposite sides of the yoke held rigidly by a nonmagnetic insert welded into place. Direct current is supplied to one of these coils to furnish excitation. By means of a filter, the alternating current generated in this coil is prevented from reaching the d-c source, which due to its low impedance, would act as a short circuit.

A capacitor is used to isolate the d-c from the second coil. The coils are connected so that their alternating currents added. The schematic circuit of the variable reluctance generator, its excitation circuit, and its output to line matching circuit are given in lefthand portion of Fig. 2.

The excitation and output circuits are combined on a single chassis. A small capacitor across the a-c output of the tachometer reduces its high-frequency harmonic content. The resultant wave shape is nearly sinusoidal. The a-c output is differentiated to reduce 60 cycle pickup, then fed into a line-matching transformer. On the other end of the line a stepup transformer is used, followed by a double differentiator and final transformer. The filtered output of the tachometer is thus an alternating current whose frequency is at all times proportional to the rotational speed of the quill. This frequency and its variation can be measured or recorded in several ways, depending upon the accuracy required and the magnitude and frequency of the speed variations.

Frequency Indication

Use of an electronic frequency meter would have required an amplifier to increase the tachometer output voltage to 0.25, 0.5 or 4 volts, depending upon the meter, but this method although convenient, is subject to inaccuracies. Commercial electronic frequency meters are usually guaranteed to give an accuracy of two percent of the full scale value if the power supply voltage is regulated, and the input voltage must be held to within 0.5 volt to obtain this accuracy. Although many frequency meters are considerably more accurate than the manufacturer's guarantee indicates, the possibility of errors as large as 1,500 rpm excluded their use.

The determination of whether a meter were accurate or not required the development of a means of calibration. As the indicating instrument scales of such meters are rather short and their motions highly damped, it was decided to use the necessary calibrating equipment directly.

The output of an audio oscillator set at approximately 2,000 cps can be mixed with the tachometer frequency and fed into a headset (or an oscilloscope). A third or beat frequency can be heard (or seen). The number of beats per unit of time is equal to the numerical difference in the component frequencies over the same unit of time.

If the numerical difference is low, such as one beat per minute, an oscilloscope or electron ray tube is particularly desirable. The oscillator output can be applied to one set of plates in the cathode ray tube and the techometer frequency to the other set, the resulting Lissajou figures are a positive visual indication of minute changes of frequency even if the beat cycle extends over a long period of time. Similarly an electron ray tube can also be used to adjust the oscillator frequency to that of the tachometer. In this instance an amplifier is needed on the output of the reluctance generator. The number of times the magic eye winks indicates the beat frequency.

To obtain aural indications of the oscillator and variable reluctance generator, a mixer unit was constructed, the circuit of which shown in the righthand portion of Fig. 2. The oscillator output was connected to a stepup transformer, then differentiated and fed into a final transformer. The line from the variable reluctance generator matching unit is also terminated in a stepup transformer, the output of which is differentiated twice and then connected to the output transformer. By means of a single pole, single throw switch, these two al-

Measuring Speed With WWV

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A variable reluctance tachometer is used to generate a frequency proportional to the speed of revolution of a shaft. This frequency is compared to that of a variable frequency oscillator. Means of obtaining harmonics of WWV's 440-cps signal for calibrating the oscillator are described

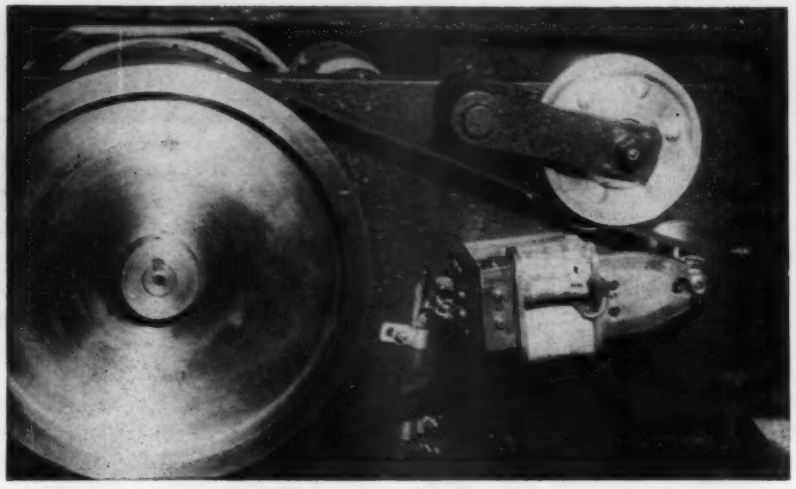


FIG. 1—The variable reluctance tachometer is at the extreme right

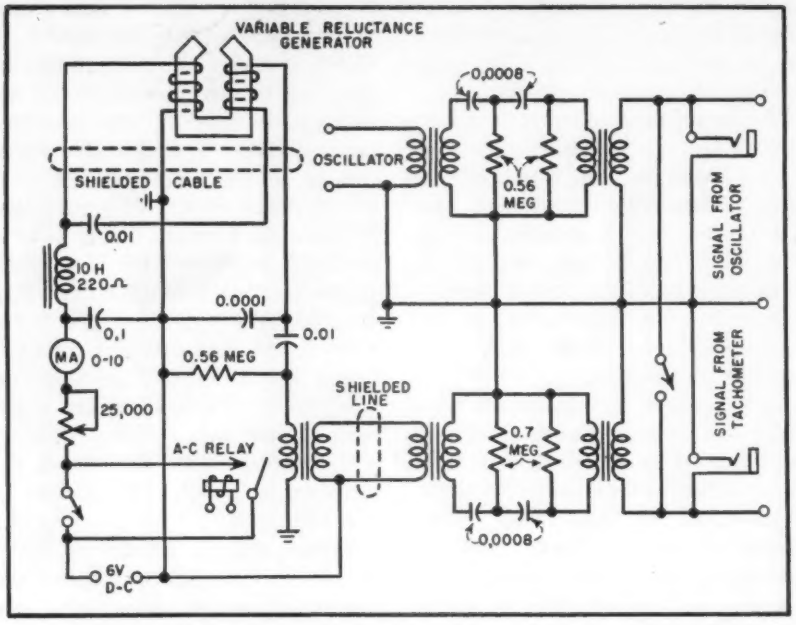


FIG. 2—At the left is the excitation and takeoff circuit for the variable reluctance tachometer; at the right is the mixer output

PRECISE speed measurements of a shaft revolving at approximately 30,000 rpm were required for an ordinance evaluation. Mechanical connection to the revolving quill on the end of the shaft was undesirable because of dynamic balancing problems at such high speed, so a variable reluctance generator was designed and constructed that develops 2,000 cps at 30,000 rpm.

Because commercial frequency meters are so highly damped that they cannot follow the rapid fluctuations in speed that were to be measured, it was necessary to use a more sensitive and accurate method. This was done by comparing the tachometer frequency to that of a calibrated oscillator.

To calibrate this oscillator, a harmonic amplifier producing precise audio-frequency check points spaced at 220-cps intervals and derived from the 440-cps modulation of WWV was designed. A novel frequency selective, degenerative limiter is incorporated in this amplifier. A center clipper is also employed, so a slice of the received signal is thereby utilized and noise is reduced considerably.

Tachometer

The end of the quill has four plane sides and four intervening sides that are segments of a circle (a square nut with rounded corners). A variable reluctance generator shown in detail in Fig. 1 was constructed to serve as a tachometer. It is mounted so that the end

the cathodes can be adjusted so that only the peaks are amplified by each grid and center clipping results.

The next stage is also push-pull, with differentiators in the grids.

The transformer coupled output is then fed through a differentiator to the first peak limiter stage. This is not a conventional limiter because only certain frequency ranges are affected and because of its degenerative action. The low frequencies are passed through a reactance coil to the dual diode, each half functioning for an alternation.

High frequencies are passed through a capacitor shunting the reactor. Thus the high and low frequencies are impressed upon the limiter. Where these have sufficient amplitude to be conducted through the limiter as determined by the setting of the bias potentiometer, the grid is excited by a potential derived from the plate, whose phase is in opposition to the incoming signal on the grid, preventing the further increase of grid potential in either direction beyond a certain point for a given set of conditions. The resulting wave might be described as a wave clipped not squarely but with ripples. The harmonic content of the output is rather high.

The remaining stages amplify the medium range of frequencies. To accomplish this, a differentiator is placed in each grid to attenuate the low frequencies, and in certain cathode circuits, parallel circuits are placed which resonate at approximately 440 cps in order to further reduce the fundamental by degeneration. Certain stages have parallel circuits in their plates to increase the selective amplification of the desired harmonics. The fundamental has been considerably reduced before the signal reaches a second limiter, but certain parts of the complex wave are of greater amplitude than others, so the limiter is employed to even out the complex wave. Because there are no appreciable low frequencies present, the limiting action is confined to the higher frequencies. The amplifier's overall frequency response is shown in Fig. 4. In some of the amplifier stages a plate resistor and capacitor are used in the load circuit. The capacitor is for the purpose of reducing the response to the excessively high frequencies.

All transformers are given resistance loading and series grid resistors are used for stability. A resistor-capacitor combination is used in all plate supply leads except in the power stage, to prevent coupling between stages through the high voltage.

To check for self oscillations, one uses various input frequencies and observes the frequencies appearing at the various binding posts (such as those numbered 1, 2, and 3 in Fig. 3) on the panel. At no point should the amplifier show a pronounced response to any one input frequency. The plate supply voltage can be from 150 to 300 volts d-c; at the higher voltage the total current drain is under 100 ma. The plate supply voltage is used to set the clipping and limiting levels, so it should be regulated. The filament transformer should be of sufficient capacity to provide current for the heaters and pilot light. It is important that this transformer be isolated physically or shielded magnetically to prevent 60-cps pickup by the harmonic amplifier. The filament leads are shielded throughout for the same purpose.

Operation

The only controls on the harmonic amplifier consist of three limiter adjustments, the first of which can serve as a gain control to supplement the receiver's control if desired. Once made, the settings of the others do not require readjustment. The first control adjusts the center clipper and the second and third adjust the peak limiters. These adjustments are not critical and can be set to operate effectively on a slice of the received signal, reducing noise. The amplitude of the signal and the degree of fading determine the amount of center clipping which can be used. The peak limiters, while adjustable, nevertheless have a slight self-regulatory feature which adjusts the limiting action according to the amplitude of the signal.

Radio receiving conditions are particularly poor at times on the West Coast, so it was necessary to calibrate the audio oscillator when reception was somewhat improved. Fading and static combine to make calibration difficult; however, extraneous man-made noise can be reduced by moving the receiver to a location a few miles from noise generating devices. Fading can be reduced by diversity reception, the receivers preferably having a common automatic gain control so that the receiver or receivers momentarily active would desensitize the others, thereby reducing the tube hiss and noise pickup. When fading was particularly pronounced, it was found that the last two amplifier stages could profitably be used.

The output of the audio oscillator can be introduced in the output stage of the harmonic amplifier. Otherwise the output of the audio oscillator can be connected directly to the amplifier or through the mixer unit.

The oscillator is adjusted until its frequency is synchronized by aural and visual means with one of the frequencies obtained from the harmonic amplifier until no beat frequency is heard. The only visual means which is satisfactory as an aid to aural means is by using an oscilloscope whose sweep is synchronized to the desired frequency. With so many harmonics and static present, Lissajou figures or magic-eye techniques cannot be used. Sharply tuned audio filters, such as used in connection with radio range receivers can be used to great advantage. The setting of the oscillator and the corresponding frequency as derived from WWV broadcasts can thus be determined.

Numerous tests were run with the equipment described herein. The equipment was operated with different quills, with and without an idler pulley, in order to simulate different speed and speed variation conditions for analysis by the tachometer. Rapid fluctuations in speed were readily detected as were small changes in speed. The factors determining speed and causing irregularities could conveniently be studied using these techniques. The equipment provides an extremely accurate means of measuring speed and rapid variations of speed and should find many applications where accurate measurements of this nature are required.

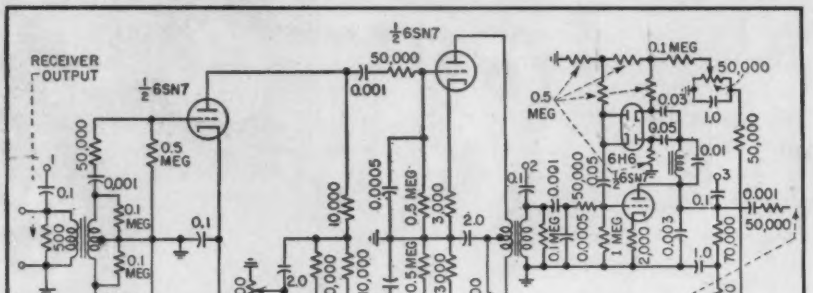
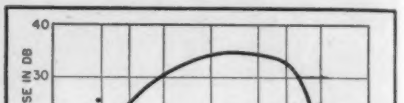


FIG. 3—Essential portions of the harmonic amplifier consists of its balanced input acting also as a center clipper, and the frequency selective, degenerative limiter

FIG. 4—Frequency response of the entire harmonic amplifier



ternating voltages can be multiplied. A difference in frequency is detected in a headset by periodic changes in amplitude or beats. When the switch is open the two voltages are not mixed and visual indicating means are then connected. If it is desired to measure a frequency difference which is too high to be counted, as above described, the mixed output can be amplified and rectified. The output of the rectifier can drive a recording galovanometer; the changes in amplitude correspond to beats.

Audio Oscillator

Accuracy of the observed data depends upon the absolute accuracy of the audio oscillator. The dial furnished by the manufacturer could not be read closely enough, so a micrometer dial (National B-189-B) and gear box (National NPW-O: 20 to 1) were installed. The number of cycles per second, per division, was thereby reduced to 14 in the vicinity of 2,000 cps. The dial graduations permit accurate reading and calibration to better than one tenth of a division, which is plus or minus 0.035 percent of the basic quill speed. The audio oscillator was modified in order to obtain the 1,760 and 2,200 cps check points on the same band. A still better dial and gear reducer combination might be used, but then the stability of the oscillator becomes the limiting factor. Similarly, the frequency range of the oscillator could have been narrowed to 450 cps.

The greatest variation of the oscillator frequency is warmup drift and it was found that the oscillator should be turned on for at least two hours prior to being used. Variations in power voltage influence the oscillator, so a voltage regulator should be used with the oscillator to insure accuracy.

Ambient temperature changes are only of minor importance in the laboratory. It was found that placing a weight on the oscillator case altered the frequency, so a rugged case assembly was constructed, and the oscillator was shock mounted to minimize the effects of vibration incurred in transporting the instrument. Moving the oscillator is always done carefully as vibration or jolting could effect the calibration.

The harmonic amplifier, described below, is connected to a radio receiver output and beat against the oscillator. Check points are obtained at 1,760 and 2,200 cycles per second corresponding to the fourth and fifth harmonics of WWV's 440 cps tone modulation. An intermediate check point is obtained at 1,980 cps. Many other check points are available between 650 cps and 5,000 cps. A curve of dial setting against frequency drawn through the various check points is used to interpolate intermediate values of frequency.

Harmonic Amplifier

The purpose of the harmonic amplifier, as stated above, is to convert one frequency, which may be considered absolutely accurate, into a number of higher frequencies, which are equally accurate and which can be used for the calibration of an audio oscillator or other devices required for frequency or time measurement. The National Bureau of Standards provides a continuous day and night broadcast of standard radio frequencies which are modulated at 440 cps, accurate to better than 1 part in 10,000,000. This broadcast was taken as the primary standard for frequency measurement. To beat the audio oscillator against the 440 cps modulation would be of little value at 2,000 cps. It was therefore necessary to design a harmonic amplifier which would develop and amplify a number of whole and fractional harmonics of the basic 440 cps frequency and at the same time effectively suppress the original frequency to prevent its interference with the desired frequency. Frequencies of 1,760, 1,980 and 2,200 cps were particularly desired in this instance for the previously described calibration.

In the harmonic amplifier, a radio receiver output feeds into a transformer used to excite the grids of a push-pull stage as shown in Fig. 3. A differentiator is connected in each grid to reduce the response to low frequencies, yet permit the desired frequencies to pass with little attenuation. A relatively low resistance is used in each plate circuit in order to obtain the desired characteristics as a clipper stage. A variable positive bias on

Permeability Tuning of

Analysis of permeability-tuned series loop and transformer-coupled loop circuits. Performance is compared with that of the familiar capacitance-tuned high-impedance type. Coil-winding data for obtaining proper pitch for oscillator tracking are also given

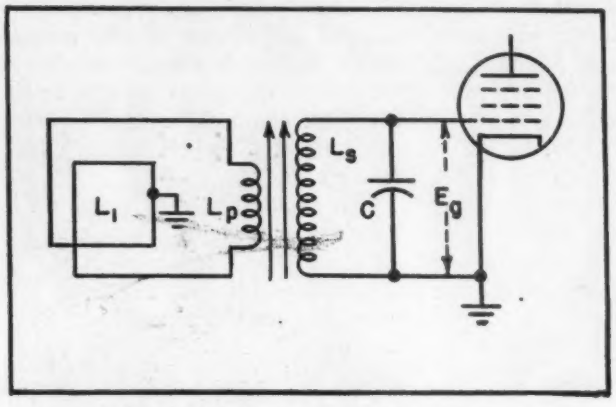


FIG. 1—Transformer-coupled loop circuit

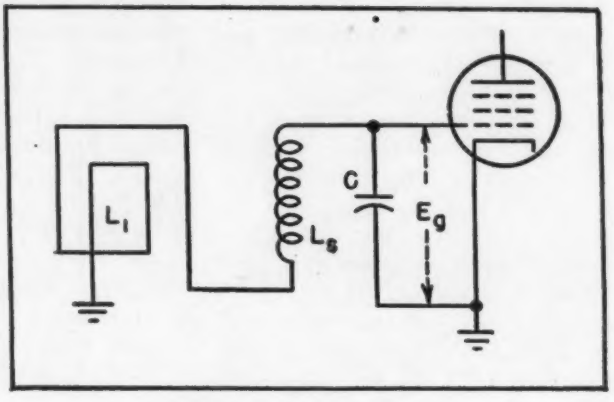


FIG. 2—Series loop circuit

PERMEABILITY tuning has been used widely in automobile receivers and has been found to be very satisfactory for such use. The advantages to be gained by this method of tuning rather than a gang capacitor are: smaller size, lower cost, and improved signal-to-noise ratio when tuning a small-capacitance antenna.

Of these advantages only lower cost would ordinarily be of great importance in the design of home receivers. Unquestionably, the greatest barrier to the wide acceptance of permeability tuning is the degradation of loop performance which is encountered, particularly in small table models.

At present there are two accepted methods of permeability tuning a loop antenna. In both cases the loop must be of the low impedance variety and is usually constructed of two to four turns of heavy copper wire or ribbon. The two methods which we will consider are:

1—The transformer-coupled circuit wherein the loop is connected to a small primary winding which is coupled to a secondary winding which in turn is tuned by an iron core. The schematic diagram appears in Fig. 1.

2—The series loop circuit wherein the loop is connected in series with the tuning coil. The schematic diagram of this connection appears in Fig. 2.

The analysis of the transformer-coupled circuit will follow very closely a previously derived method for the capacitance-tuned low-impedance loop[1]. The analysis of the series loop circuit will follow the method given by Polydoroff[2]. Gain and signal-to-noise ratio will then be compared for the two circuits and a further comparison made with the usual high-impedance capacitance-tuned loop antenna.

For the purposes of these comparisons, a table model receiver having an area of 82 square inches available for the loop will be considered. Knowing the loop area and the number of turns, the effective height of the loop is found from the formula

Table I—Series Loop Circuit

Frequency in kc	Q	Loop Effective Height μv/m	Figure of Merit	Tuned Circuit Impedance, ωLQ
1,500	90	0.0093	0.836	145,000 ohms
1,000	95	0.0062	0.588	231,000 ohms
600	110	0.0037	0.408	448,000 ohms

Broadcast Receivers

By
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$$he = \frac{2\pi\ NA}{\lambda} \text{ in microvolts per meter} \quad (1)$$

The effective height of the loop multiplied by the gain of the input circuit is equal to the figure of merit of the loop.

To find the thermal-noise produced in the input circuit, the tuned circuit impedance must be known, and this will be calculated for each of the three type circuits compared here.

Analysis of Series Loop Circuit

The factor which determines the gain obtainable with the series loop is the tuning range available in the permeability-tuned coil. It was determined experimentally that a linear pitch, 130-microhenry, progressive-wound coil on Bakelite tubing having dimensions of 0.206 inch I.D. and 0.226 O.D., tuned with a commercially available iron core whose dimensions are 0.200 inch diameter and 1.5 inch long, could be made to have an inductance change of 11 to 1.

Inasmuch as the dial calibration which can be obtained with a linear pitch coil was found to be somewhat more crowded at the high-frequencies than is usual with a tuning gang and since this crowding was deemed to be unsatisfactory, a variable-pitch coil having three different pitches was designed and was found to be a great improvement over ganged capacitors insofar as dial crowding is concerned. Such a coil having an initial inductance of 130 microhenries was found to have an inductance change of 10.3 to 1.

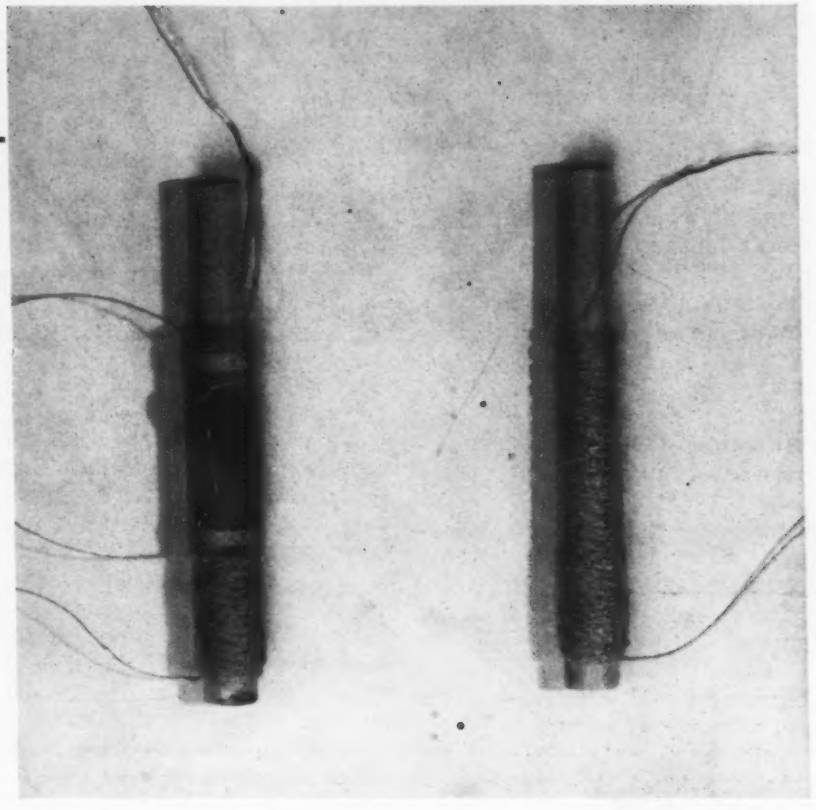


FIG. 3—Left, the primary is wound in two sections over the secondary. Full view of the secondary winding appears at right

Applying a formula[2] to find the size of the loop which may be tuned we have

$$L_1 = \frac{L_0\left[\mu_{eff} - \frac{(f_{max})^2}{(f_{min})^2}\right]}{\frac{(f_{max})^2}{(f_{min})^2} - 1} \quad (2)$$

where L_1 = loop inductance
L_0 = tuning coil air inductance

To tune the complete broadcast band with some allowance for drift and misalignment, f_{max} must be at least 1,610 kc and f_{min} at most 535 kc. This is a frequency range of 3.01 to 1 or the equivalent of a 9.06 to 1 inductance change. Substituting in Eq. 2 with a μ_{eff} of 10.3 for the variable pitch coil,

$$L_1 = \frac{130\,[10.3 - 9.06]}{9.06 - 1} = 20\ \mu h$$

For the 82 square-inch loop which is being used in this instance, it was found that 20 μh was obtainable with 5.6 turns. The effective height of this loop is calculated by the use of Eq. 1. The Q of the circuit is very nearly the Q of the tuning coil itself since it forms the greater part of the total inductance, and figure of merit equals $heXQ$.

Knowing that the total inductance at 1,610 kc is 130 + 20 or 150 μh, the inductance at other frequencies is found by multiplying 150 by the square of the frequency ratios. For example at 1,500 kc,

TABLE IV—Comparison of Circuits

Frequency in kc	Figure of Merit	Grid noise voltage 6SG7 Input Tube μv	ENSI μv/m 6SG7 Input Tube	Grid noise voltage 6SA7 Input Tube μv	ENSI μv/m 6SA7 Input Tube
Series Loop Circuit					
1,500	0.836	4.06	4.86	6.62	7.9
1,000	0.588	5.14	8.73	7.35	12.5
600	0.408	7.15	17.5	8.86	21.7
Transformer-Coupled Circuit					
1,500	0.395	3.51	8.9	6.4	16.2
1,000	0.515	4.16	8.1	6.67	12.9
600	0.640	5.32	8.3	7.46	11.7
Capacitance-tuned High-impedance Loop					
1,500	1.98	3.71	1.87	6.4	3.23
1,500	1.98	3.3	2.1	6.17	3.9
600	0.795	2.35	3.0	5.75	7.25

transformer, the figure of merit of the loop system is the effective height of the loop multiplied by the gain of the transformer. Pertinent characteristics for the transformer-coupled circuit are shown in Table II.

Capacitance-Tuned High-impedance Loop

To satisfy tracking considerations, it was found that the capacitance-tuned high-impedance loop should have an inductance of 183 μh. Knowing that a 4-turn loop of this area had an inductance of 10 μh we may calculate the turns of the 183-μh loop as

$$\sqrt{\frac{183}{10}} \times 4 = 17.1 \text{ turns}$$

The figure of merit for this loop circuit is loop effective height multiplied by loop Q. Table III shows the characteristics for the capacitance-tuned high-impedance loop including the loop Q when mounted about two inches from its associated chassis. Figure 4 shows this type of loop circuit.

In most receivers sufficient intermediate-frequency gain is available so that actual gain of the antenna circuit is of minor importance compared with the signal-to-noise ratio of this circuit.

The input circuit noise[4,5] is

$$E_i = 1.28 \times 10^{-10} \sqrt{FR} \qquad (8)$$

where E_i is the noise in volts

F = receiver bandwidth in cycles (7,000 cycles in the present analysis)

R = tuned circuit impedance in ohms connected to the input tube grid plus the equivalent input noise resistance of the input tube

The equivalent input noise resistance (shot noise referred to the grid circuit) is[5] 3,300 ohms for a 6SG7 tuned r-f amplifier. This noise resistance is negligible compared with the tuned circuit impedance. However, in the case of a 6SA7 converter tube used as the input tube, the equivalent noise resistance is 240,000 ohms and is of considerable importance in determining the signal-to-noise ratio.

If we divide the grid circuit noise as given by Eq. 8 by the figure of merit of the loop system, a measure of the signal-to-noise ratio for the receiver is obtained. In fact, by thus referring the noise to the input of the receiver, we have obtained the familiar ENSI (equivalent noise signal input) expressed in microvolts noise per meter which is usually used to express the signal-to-noise ratio of receivers. Using this method of analysis and the information previously derived for the three types of loop circuits, we can tabulate the performance of the loop circuits for two extreme types of input tubes as shown in Table IV.

Obviously, the permeability-tuned loop is inferior to the capacitance-tuned type with respect to both gain and signal-to-noise ratio.

When input tube noise is neglected, the actual value of tuned circuit inductance has no effect on signal-to-noise ratio, although gain is nearly proportional to the square root of inductance. When a 6SA7 is used as the input tube, it is desirable to build the tuned circuit impedance to as high a value as possible to overshadow tube noise.

For the foregoing analysis, the high inductance permeability-tuned coil was not considered, for it was found that a variable pitch winding could not be wound satisfactorily above 130 μh. It was found to be quite practical, however, to wind linear pitch progressive windings on a 0.226 diameter form with 250 μh inductance. Such a coil showed an inductance range of 10.6 to 1 (this compares with the 11 to 1 range for a 130-μh linear pitch coil).

An analysis of performance with this 250-μh coil is of interest, because it represents the best which we can do for a small permeability-tuned receiver with no r-f stage. Assuming use of the series loop circuit, the loop inductance can be calculated to be 47.7 μh consisting of 8.7 turns of the same area used for the previous loops. Table V is a summary of the performance characteristics using this tuning coil and loop.

Any improvement which can be made in either iron core or coil to improve tuning range will, of course, result in better performance for any of the loop-tuning circuits, insofar as signal-to-noise ratio is concerned.

One advantage which the transformer-coupled circuit enjoys over the series type, besides improved gain at the low frequencies, is the fact that the loop may be center-tapped to ground in order to provide balance to extraneous noise pickup. This is only a slight advantage, however, since the series loop

$$L = \frac{(1{,}610)^2}{(1{,}500)} \times 150 = 172\ \mu h$$

Some of the important characteristics of this input circuit are shown in Table I.

The factors which must be known for the calculation of the transformer-coupled loop[1]

- k = coefficient of coupling between primary and secondary. This value varies as the coil is tuned
- m = ratio of primary inductance to loop inductance
- L_{eqv} = total inductance as seen at the grid of the tube
- Q_{eqv} = total circuit Q as seen at the grid of the tube.

While it is highly desirable to keep both m and k constant as L_s is tuned, this is not feasible. In order that k be as large as possible across the entire band, it was found desirable to wind part of the primary over the top of the secondary (top being considered the end of the secondary through which the iron core enters), the rest of the primary being concentrated at a point about half-way down on the secondary winding. Such a primary winding is shown in Fig. 3, assembled on the secondary.

Theoretically, any number of turns of the low-impedance loop can be coupled into the secondary and the same signal obtained at the grid. Actually, however, larger loop inductances result in more primary turns which yield a somewhat higher coefficient of coupling than small primaries. For this reason when dealing with table model loops, a 4-turn loop gives better results than a 2-turn loop. Also, Q is improved with the increased turns.

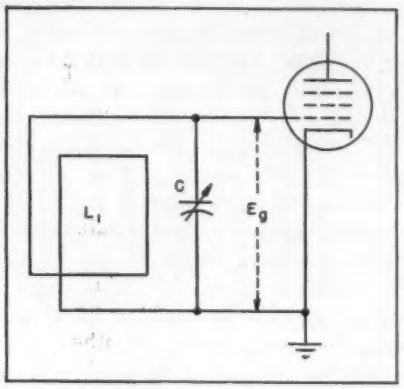


FIG. 4 — High-impedance capacitance-tuned loop circuit

TABLE II—Transformer-Coupled Loop

Frequency in kc	Transformer Gain	Loop Effective Height $\mu v/m$	Figure of Merit	Tuned Circuit Impedance $\omega L_{eqv} Q_{eqv}$
1,500	59.5	0.00664	0.395	108,500 ohms
1,000	116.5	0.00442	0.515	151,500 ohms
600	241	0.00265	0.640	247,000 ohms

TABLE III—Capacitance-Tuned Loop

Frequency	Q	Effective Height in $\mu v/m$	Figure of Merit in $\mu v/m$	Tuned Circuit Impedance ωLQ
1,500	70	0.0284	1.98	120,500 ohms
1,000	83	0.0189	1.57	95,500 ohms
600	70	0.0113	0.795	48,300 ohms

In the comparison made here, a 4-turn loop of 82-square-inch area having an inductance of 10 μh was used with the transformer-coupled input circuit.

Since the presence of the primary winding connected through the loop reduces the tuning range of the secondary, the size of the primary winding must be determined experimentally, although if the coefficient of coupling is known, the maximum size of the primary needed to maintain tuning range may be calculated. This primary inductance is usually of necessity smaller than the optimum value which should be used for the coefficient of coupling encountered. Actual values of k and m for a 130-μh variable pitch secondary coupled to a 10-μh loop are given below. These values were determined experimentally in order that the tuning range be covered.

Frequency	k	m
1,500 kc	47.%	0.28
1,000 kc	61.3%	0.34
600 kc	70.%	0.46

Purely theoretical considerations would have made $m = 0.75$ at 1,500 kc and $m = 0.47$ at 600 kc, thus[1]

$$Q_{eqv} = Q_s \frac{(1 + m - mk^2)}{(1 + m + 2mk^2)} \qquad (3)$$

The assumption used in deriving this equation was that the total primary circuit Q made up of both loop and primary inductance is equal to $(\frac{1}{2})\ Q_s$. This is close to being the actual case and at

$$1{,}500\text{ kc},\ Q_{eqv} = 90\frac{(1 + 0.28 - 0.062)}{(1 + 0.28 + 0.124)} = 78$$

$$1{,}000\text{ kc},\ Q_{eqv} = 95\frac{(1 + 0.34 - 0.128)}{(1 + 0.34 + 0.256)} = 72.4$$

$$600\text{ kc},\ Q_{eqv} = 110\frac{(1 + 0.46 - 0.225)}{(1 + 0.46 + 0.45\ )} = 71.2$$

$$L_{eqv} = L_s \frac{(1 + m - mk^2)}{(\quad 1 + m \quad)} \qquad (4)$$

Since at 1,610 kc, it was found that $k = 30.3$ percent and $m = 0.15$,

$$L_{eqv} = 130\frac{(1 + 0.15 - 0.0138)}{(\quad 1 + 0.15 \quad)} = 128.2\ \mu h.$$

Knowing the tuning inductance at 1,600 kc, the inductances at other frequencies can be calculated as before for the series circuit[1]

$$\text{Gain} = kQ_{eqv}(L_s/L_1)^{1/2}\left[\frac{m^{1/2}}{1 + m}\right] \qquad (5)$$

From Eq. 5

$$L_s = \frac{L_{eqv}(1 + m)}{1 + m - mk^2} \qquad (6)$$

Then

$$\text{Gain} = kQ_{eqv}\left[\frac{L_{eqv}}{L_1}\right]^{1/2}\left[\frac{m}{(1 + m)(1 + m - mk^2)}\right]^{1/2} \qquad (7)$$

Knowing the gain of the input

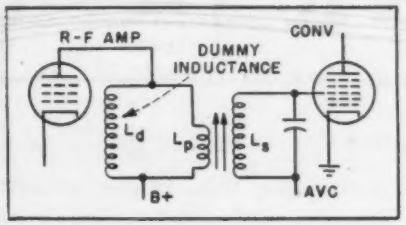


FIG. 6—Dummy inductance simulates the loop

Table V—250-μh Coil in Series Loop Circuit

Frequency in kc	Figure of merit	ωLQ	ENSI 6SG7 tube μv/m	ENSI 6SA7 tube μv/m
1,500	1.28	272,000 ohms	4.35	5.5
1,000	0.915	460,000 ohms	7.9	9.8
600	0.635	885,000 ohms	15.7	17.9

coil must also have a variable pitch which corresponds. For the series loop it is only necessary that the pitch multiplying factors and proportion of turns in each section be the same for both antenna and oscillator coil. Beyond that the design procedure is the same as that previously used for the linear coils.

For example, the antenna coil consists of a progressive-universal winding of three separate pitches as follows: 83 turns at 177 turns per inch, 100 turns at 247 turns per inch, 157 turns at 363 turns per inch, for a total of 340 turns and a winding length of 1.375 inches.

Experience indicates that a convenient oscillator coil of around 20 μh should have about 130 turns. We then divide each of the above pitch figures by a factor of 2.5 to obtain the number of turns in each section of the oscillator coil. This comes out to be 33 turns, 40 turns and 63 turns. All that remains is to find the actual pitch of each section so that the total oscillator coil length is 1.375 inches. Since turns divided by TPI, turns per inch, equal winding length, we may set up an equation for TPI as follows

$$\frac{33}{\frac{177}{247}(\text{TPI})} + \frac{40}{\text{TPI}} + \frac{63}{\frac{363}{247}(\text{TPI})} = 1.375$$

solving, TPI = 94

The oscillator coil should then be wound

33 turns at $94 \times \frac{177}{247} = 67.3$ TPI

40 turns at 94 TPI

63 turns at $94 \times \frac{363}{247} = 138$ TPI

Such an oscillator coil is wound on thin-wall tubing and the required series inductance is determined in the same manner as was used for linear coils. A new coil of larger diameter may then be wound using the same number of turns and pitch to incorporate the necessary series inductance. An oscillator coil of this type appears in Fig. 5.

The transformer-coupled loop with variable pitch tuning coils is the most difficult type to track for the loop primary has a pronounced effect on the secondary tuning curve. Here it is best to start with an oscillator coil whose pitch variations correspond with those of the antenna coil as before, but mistracking will inevitably be found. The frequencies where this mistracking occurs as well as the direction of misalignment are noted.

As a general rule when more inductance is required in the antenna coil for alignment above the middle frequency (at around 1,200 or 1,300 kc), the oscillator coil winding pitch must be reduced (more turns per inch) at this end of the oscillator coil. When more inductance is required in the antenna coil below the middle frequency (around 700 or 800 kc) the middle pitch of the oscillator coil should be increased (less turns per inch).

To determine whether oscillator pitch must be reduced or increased at any particular frequency, 1,000 kc is used as the starting point since the iron cores are aligned there. Thus if more inductance is needed in the antenna coil at 1,200 kc for tracking, the oscillator core has moved too rapidly, up from 1,000 kc, and so the winding pitch must be reduced between 1,000 kc and 1,200 kc to correct.

Inasmuch as varying oscillator series inductance has somewhat the same effect as changing pitch, various combinations are possible which appear to give reasonably good tracking, but one particular combination will usually be best. Lag or lead of the oscillator core with respect to antenna core must be watched. By this is meant that the oscillator core may be entering its coil sooner or later than the antenna core. This is not a desirable condition since it causes tracking errors at one end of the travel.

Very often the low-frequency pitch of the oscillator coil may be varied to correct for lead or lag, when a shunt inductance padder is used. Decreasing pitch at the low-frequency end of the oscillator coil will lower the shunt padder inductance, and this in turn will cause less oscillator core lag at 1,000 kc.

If a tuned r-f stage is used with the transformer-coupled loop, a primary winding similar to that used for the loop may also be wound on the r-f coil and a dummy inductance connected to this primary to simulate the loop. The circuit of Fig. 6 has been used quite successfully. It is also possible to use different pitch variations in the r-f coil from those in the antenna coil to obtain tracking without the necessity for a primary winding and dummy loop inductance.

References

(1) L. O. Vladimir, Low-impedance Loop Antenna for Broadcast Receivers, ELECTRONICS Sept. 1946.
(2) W. J. Polydoroff, Permeability Tuning, ELECTRONICS, Nov. 1945.
(3) W. J. Polydoroff and A. J. Klapperich, Effective Permeability of High Frequency Iron Cores, *Radio*, Nov. 1945.
(4) J. B. Johnson and F. B. Llewellyn, Limits to Amplification, *Bell Sys. Tech. Jour.*, Jan. 1935.
(5) W. A. Harris, Fluctuations in Vacuum Tube Amplifiers and Input Systems, *RCA Review*, Apr. 1941.
(6) A. W. Simon, Tracking Permeability-Tuned Circuits, ELECTRONICS, Sept. 1946.

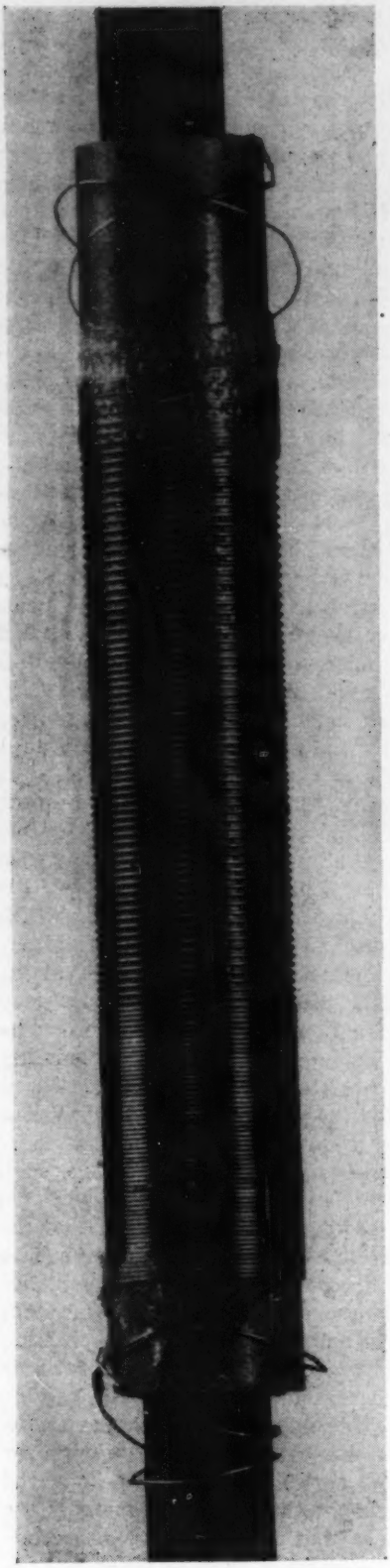


FIG. 5—Blown up to show the three different pitches formed in the winding process, this oscillator coil is used to track with the r-f coil shown in Fig. 3

is usually of low enough impedance so that noise pickup due to capacity effects is small.

With permeability tuning in a small table model receiver, the signal-to-noise ratio will be down from two to five times depending on the circuit used, the input tube and loop parameters. With some sacrifice of dial scale linearity, the gain need not be down more than two times, and this may often be regained in the i-f portion of the receiver.

A console receiver with a large area available for a low-impedance loop may have a signal-to-noise ratio equal to or better than a gang-capacitor tuned receiver, and may be done without any impairment of dial scale linearity.

Tracking

While a mathematical approach[4] to the tracking of a permeability-tuned oscillator coil to the r-f coils is possible, the results are invariably inconclusive. The majority of development engineers will undoubtedly prefer an experimental approach just as they have done with gang capacitor tracking in the past. By using variable pitch oscillator coils, it is possible to obtain nearly perfect tracking, and, after a little practice, the design procedure is not lengthy.

The simplest case is one which involves a linear-pitch progressive-wound antenna coil with a series loop. If all iron cores are alike and a shunt inductance padder is used, this corresponds exactly with the gang capacitor case where all sections are alike and an oscillator series capacitance padder is used. An oscillator coil consisting of a solenoid of some convenient wire size and pitch should be wound on the same size tubing used for the antenna coil. The length of the oscillator coil should be equal to that of the antenna coil. It has been found that No. 34F, Formex or Formvar, wire with sufficient pitch to give an air inductance of about 18 μh works well. Such a coil covers too much range to track, and the range can be limited by inserting a fixed series inductance.

The alignment procedure should be as follows: With cores out of the coils by about $\frac{1}{8}$ inch, align the oscillator to the top frequency (usually about 1,610 kc). Peak antenna trimmer. Tune receiver to 1,000 kc and adjust iron core in antenna coil for maximum sensitivity. Tune receiver to about 580 kc and rock-in inductance padder for maximum sensitivity. Repeat entire procedure.

If it is found that mistracking occurs so that the antenna coil requires more capacitance (or inductance) at frequencies between 1,000 and 1,610 kc and further requires less capacitance or inductance at frequencies between 1,000 and 580 kc, the series inductance should be reduced to obtain tracking. Conversely, if it is found that the antenna coil requires less capacitance to align above the middle frequency and more capacitance to align below the middle, the series inductance should be increased.

After the correct value of series inductance has been determined, it may be measured along with the oscillator coil to find what total value of oscillator inductance is required. A new coil is then wound on a larger diameter tubing using the same wire size, pitch, and number of turns as before, but the diameter of the new coil is such that the correct total inductance is obtained.

As an example, it was found that a series inductance of 6.0 μh was required with an 18.0 μh-oscillator coil which had been wound on 0.226 O.D. tubing. A new coil having the same wire size and number of turns was wound on 0.260 O.D. tubing to have 24μh inductance. This coil tracked satisfactorily. It will be found that inductance increases as the square of the diameter, within narrow limits, for solenoids of the general configuration used for oscillator coils. If a tuned r-f coil is to be used in addition to the antenna coil, it should be wound on a suitable diameter tubing so that its inductance is equal to that of the antenna coil plus the loop.

When the antenna coil is a variable pitch winding, the oscillator

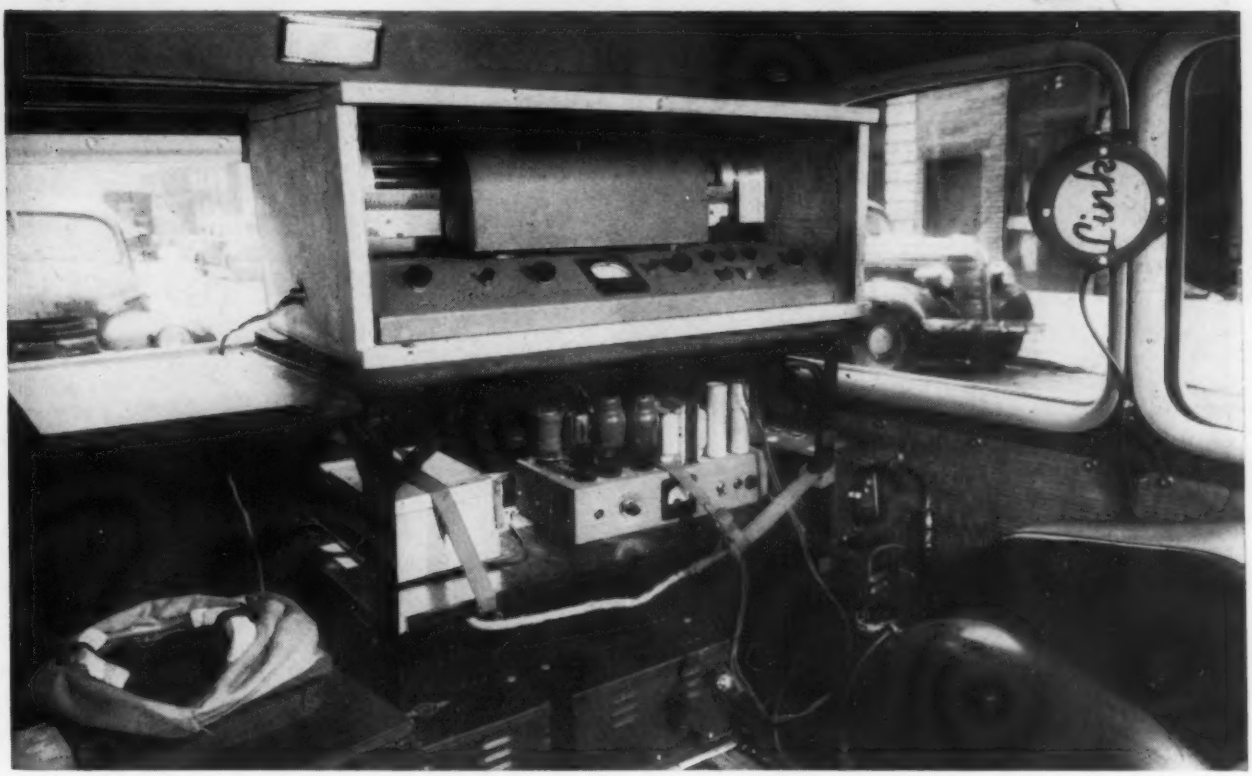
PRESS PHOTOS

transmitter or be keyed by a suitable receiver.

In operation, the photo to be transmitted is wrapped around a cylindrical drum that is motor-driven and synchronized by means of a quartz-crystal oscillator with a comparable drum on the receiving unit. A phototube, scanning the picture in spiral fashion at the rate of 90 rpm, translates the various shades of black, gray and white into electrical currents of varying character. These currents are processed and fed over the lines in the form of an 1,800 cps amplitude-modulated signal to the receiving unit where they are inversely processed to produce the original picture. Transmission time for a 5 by 7 inch photograph is about six minutes.

The picture signal for the radio

Temporary 152-162 megacycle antenna with a power gain of 3 erected on the *Daily Mirror* building roof



Interior of the Jeep station wagon. Standard mobile f-m communications equipment is on the floor. Immediately above are the dynamotor and picture frequency standard, with the Soundphoto machine in a lead-lined box on top of the table

VHF LINK FOR

New utilization of vhf mobile f-m radio equipment puts a photograph on the picture editor's desk eight minutes after the event. Extension of the technique will allow nationwide picture distribution direct from the news scene

Station wagon with mobile radio and picture-transmitting equipment installed. New York *Daily Mirror* chief photographer, John J. Reidy uses the two-way link before engineer Charles Smith connects the Soundphoto equipment in place of the microphone

RADIO AND WIRE circuits have already established themselves as a necessary means for conveying spot news photographs from the locale of an event to newspaper plants. Recently successful experiments were completed by the New York Daily Mirror in which prints produced in an automobile immediately after exposure were transmitted to the editor's desk in less time than the negatives could have been delivered by usual motorcycle courier.

That this method will probably become standard for pictorial news coverage is indicated by the fact arrangements are now being made for leasing permanent sites for installation of remote receiving and transmitting equipment. Application has been made to the FCC for a construction permit and complete radio and picture transmission equipment has been ordered.

The picture equipment used at both terminals of the test radio circuit was standard apparatus manufactured by International News Soundphoto. Each one comprises a complete picture transmitter and receiver. These machines are customarily connected together in pairs or many of them may be used in multiple, using leased wire lines. Any one of the equipments can be used as the transmitter, the others serving as receivers. Clear reproducible photographs up to 8 by 10 inches in size can be sent to any point in the network of stations. A slight modification in the input and output circuits makes it possible to adapt these machines for radio service so that they can key a radio

Effect of Feed on Pattern of Wire Antennas

Measured radiation patterns for straight wire antennas of various lengths from a half wavelength to three wavelengths and fed at various points are presented herewith. They show that feed point affects the number, orientation, and magnitude of the lobes

By

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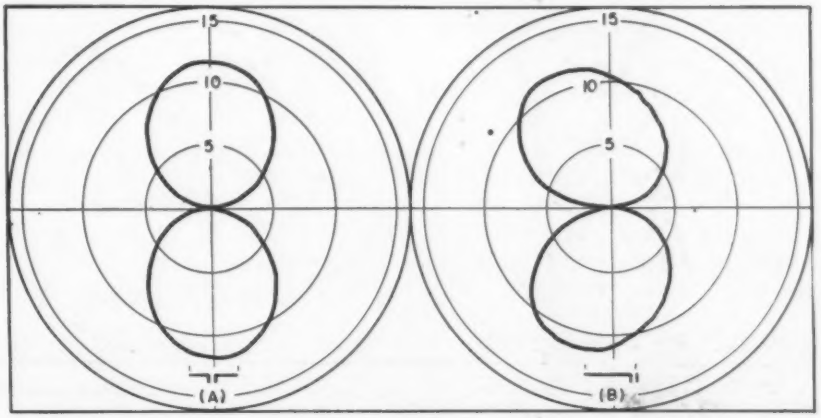


FIG. 1—Radiation from a half-wavelength antenna. Antenna outline with each pattern shows feed point; outline marked off in half wavelengths

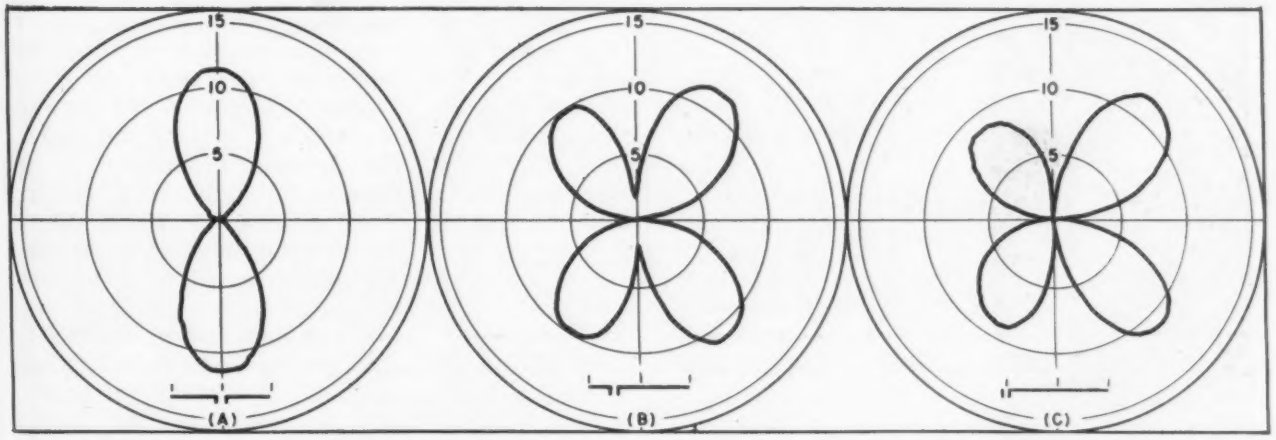


FIG. 2—Shape of field strength pattern of an antenna one-wavelength long depends on the location of the feed point

RADIATION PATTERNS of wire antennas one-half wavelength or longer are dependent on the position of feed used to excite the antenna. There has been considerable confusion in published handbooks as to just how a certain length antenna is fed to get the desired pattern. This investigation was made to determine the effects of the position of feed upon the pattern of wire antennas.

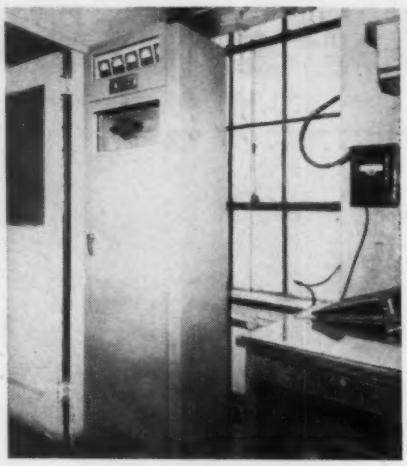
No attempt will be made to explain the results except to state that the current distribution differs appreciably from a sinusoidal distribution for certain off-center feeds.

Because the pattern of a single

tests was fed to the output of a Link Radio Corp. standard mobile f-m transmitter of the type used for police, taxicab, truck and similar service. This equipment, which is crystal controlled, operates from a heavy-duty car battery that is usually supplemented by a special generator for floating the additional load and keeping the battery well charged. Frequency of operation during the test was on 158.07 mc, with a total modulation swing of 40 kc, using the Armstrong phase system. The audio response of the equipment is essentially flat from 350 to 5,000 cycles.

A thin flexible whip antenna, 18 inches long, mounted on the metal roof of the car served as the transmitting antenna. Signals at the receiving location were strong despite the low antenna elevation and the congested locations in which the equipment was used.

At the fixed location conventional vhf transmitter-receiver equipment was installed and connected to a temporary antenna with a power gain of 3 atop the *Mirror* building.



Remotely controlled f-m transmitting and receiving equipment installed in penthouse near the antenna

This equipment was remotely controlled from the dark-room operating position several floors below.

Although the initial commercial installation will use a single fixed receiving location common to the talk-back transmitter, a much more extensive receiving system is considered necessary for eventual picture-transmission coverage of metropolitan New York. Probably as many as five separate locations at diverse points will be required to receive good pictures from outlying areas. At these points receivers will be in continuous operation and connected by telephone lines to the central operating post.

To further extend the system, portable receiving equipment can be parked near convenient telephone facilities and within receiving range of the mobile phototransmitter. The receiver will then serve as a relay point between the radio and wire links, making it possible to put news shots into the office of every subscriber in the continental network not more than fifteen minutes after the original picture is taken.

Acknowledgements

We are indebted to John J. Reidy, chief photographer of the *New York Daily Mirror*, Robert Easson, engineer of *International News* Soundphoto laboratory, and to engineers of Link Radio Corp. for pictures and information used here.—A.A.McK.

Darkroom used as control point for the experimental picture transmission system. At a warning signal from the mobile transmitter, the picture apparatus is connected and the control man refrains from using his transmitter until conclusion of the picture

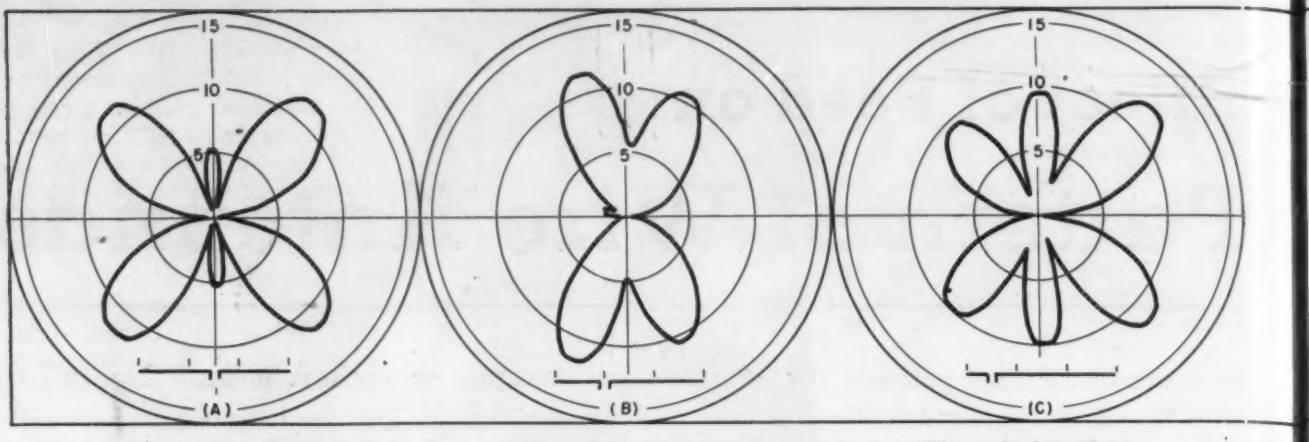


FIG. 3—Filed strength patterns of a one and one-half wavelength antenna for four different feed positions

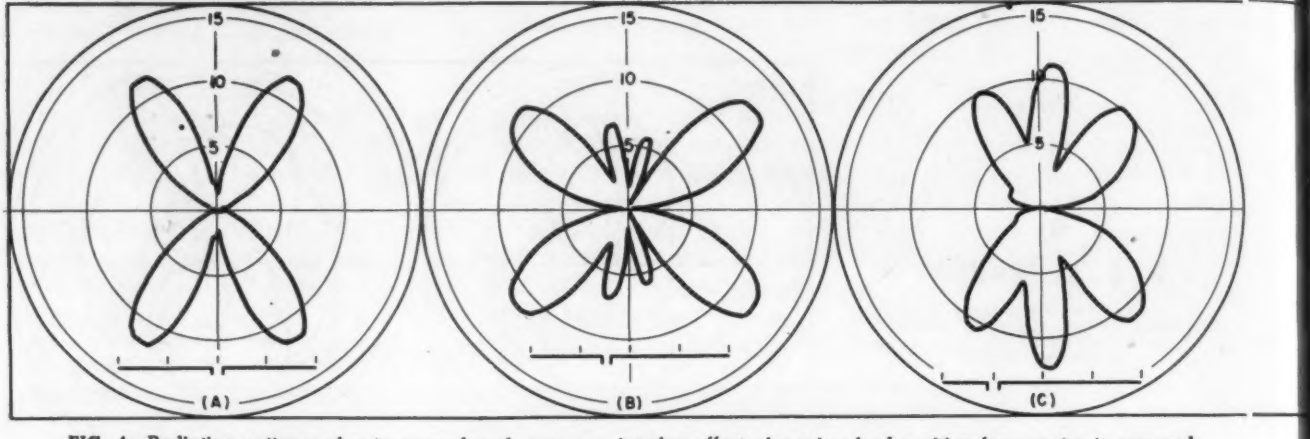


FIG. 4—Radiation patterns of a two-wavelength antenna showing effect of moving feed position from center to one end

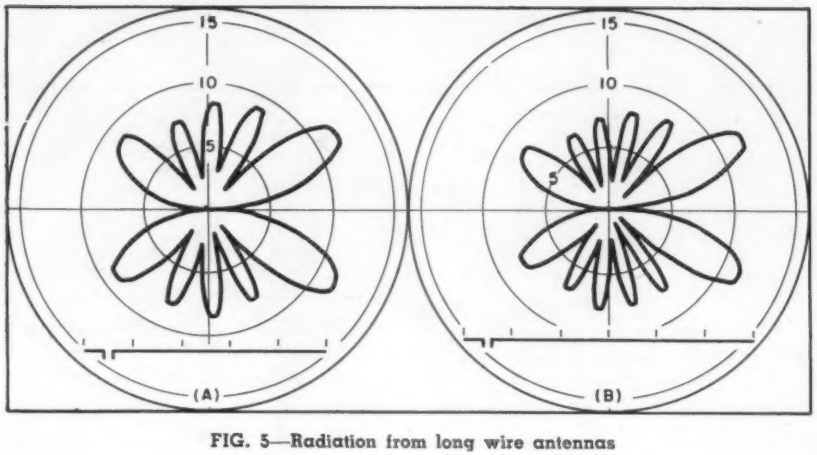
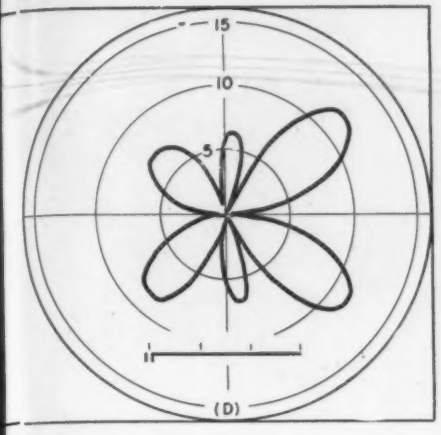


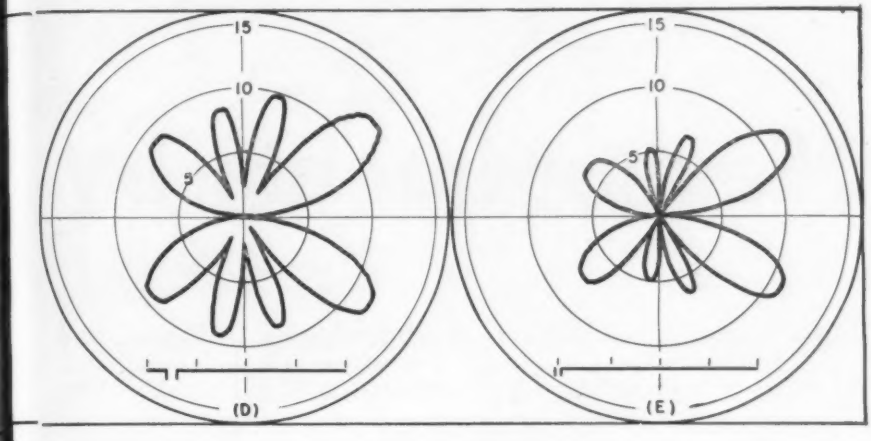
FIG. 5—Radiation from long wire antennas

fed wire antenna is independent of the impedance match between it and the receiver or transmitter, it was not necessary to have a perfect impedance match between the antenna and the detector. However, the receiver had a coaxial feed and, therefore, a balance to unbalance transformer had to be used. In order to preserve the balance, it was necessary to have a partial impedance match. In the case of high impedance feeds (end feeds or feeds an even number of half wavelengths from the end) a quarter wave section of parallel wire transmission line was inserted between the antenna and the balancing unit.

The field strength patterns that are shown in the accompanying figures were measured by using scale models of the antennas at 10 and 20 cm. This method of measuring field strength patterns was used by the Antenna Laboratory of the Ohio State University Research Foundation during World War II for the determination of aircraft antenna characteristics (see ELECTRONICS cover, May 1947).

The equipment used to measure these patterns consisted of an electro-magnetic transmitting horn, a rotating table upon which a hollow vertical plywood shaft was fastened, the antenna to be measured being mounted on top of the shaft and supported by polystyrene rods when necessary. The antenna to be measured was then a receiving antenna. A Littelfuse bolometer was used as the detector. The pat-





terns were continuously recorded by means of a selsyn system between the rotating table and shaft and the recording table. A concentric line lighthouse tube oscillator and a 10 cm two-cavity klystron were used as transmitting sources.

Measurements

The patterns of the half wavelength antenna shown in Figure 1 were taken using first a balanced current feed at the center of the half wavelength and then a voltage feed at the end of the half wavelength wire. (Each diagram has an illustration of its antenna, marked in half wavelengths.) It was apparent that the current distribution on the half wavelength antenna is not sinusoidal when it was end fed. With end feeding the lobes are displaced 15 to 20 degrees from their position when the half wavelength wire was center fed.

The full wavelength antenna was measured using a balanced voltage feed at the center of the antenna. The two half-wavelength portions of the antenna then have in-phase antenna currents flowing on them. The pattern obtained using this feed point is shown in Fig. 2A. The feed point was moved one-quarter wavelength off center and fed with a balanced current feed. The pattern (Fig. 2B) was nearly that which is usually published for a full wavelength antenna. However, the two lobes of energy on the same side of the wire are not equal in amplitude, but were present at about the published angle of 54 degrees. The minimum differed in amplitude from those obtained when the same length was end fed. When the full wavelength wire was end fed with a voltage feed, the lobes on both sides of the wire closest to the fed end of the antenna were reduced in amplitude even more than when the feed point was a quarter wavelength from the end of the wire, as seen in Fig. 2C.

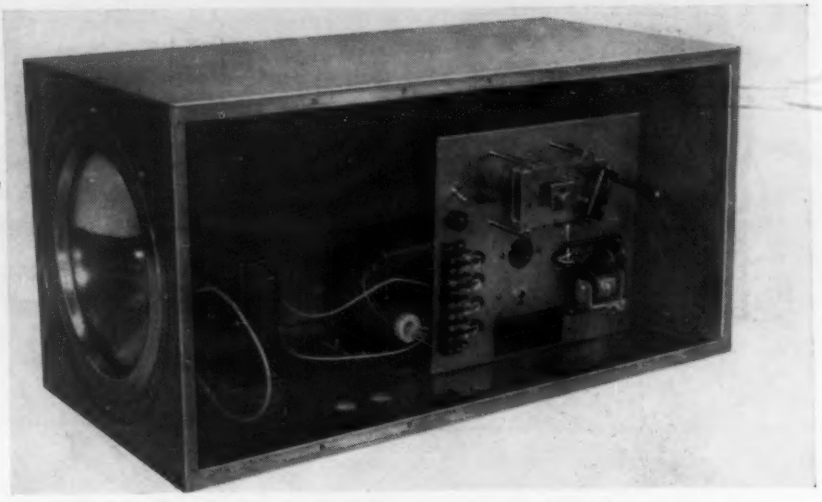
A one and one-half wavelength wire was measured for center feed, Fig. 3A, one-quarter wavelength off center, Fig. 3B, one-half wavelength off center, Fig. 3C, and end fed, Fig. 3D. It is interesting to note the differences in amplitude of the broadside lobes and that the position of the large lobes off the free end of the end fed wire are slightly closer than the corresponding lobes for other feed points.

A two wavelength wire was measured using a balanced voltage feed at the center, (Fig. 4A), a current feed one-quarter wavelength off center (Fig. 4B), a voltage feed a half wavelength off center (Fig. 4C), a current feed three-quarters wavelength off center (Fig. 4D), and end fed with a voltage type feed (Fig. 4E). Different distributions must be present on the antenna for different feeds and the current distributions apparently are not sinusoidal even for the balanced center feed since the broadside minima are not complete. The pattern with the feed one-quarter wavelength off center (Fig. 4B), indicates that current distributions on each half of the wire were not identical let alone sinusoidal. When the wire was fed one-half wavelength off center (Fig. 4C), the minima were not complete and of different values due to the unbalanced current distribution along the antenna.

When the wire was fed three-quarters wavelength off center (Fig. 4D), the current distribution was again different from that when the antenna was end fed (Fig. 4E), as it was for the same types of feeds using the three-half wavelengths antenna (Fig. 3). The large lobes off the free end of the wire were again closer to the wire when the two-wavelength antenna was fed three-quarter wavelength off center, (Fig. 4D), than when the wire was fed one-quarter wavelength from the end (Fig. 4E).

Also shown in Figure 5 are the patterns of longer wires, namely, two and one-half wavelengths and three wavelengths long. Time did not permit further measurements. The minima were not complete as was shown before for similar type feeds used on shorter lengths of wire. Similar effects of non-sinusoidal current distributions were present when unterminated rhombic and V antennas were measured.

This investigation was prompted by discussion between C. H. Page and G. H. Brown at the I.R.E. 1947 Winter Convention in New York City, of the effect of the diameter of the antenna on the pattern when various positions of feeds are used.



Transmissometer receiver. Light from the source is focused on a photoelectric tube by a lens. The receiver converts received energy to pulses, the frequency of which varies with light

By

C. A. DOUGLAS

National Bureau of Standards
Washington, D. C.

Visibility Measurements by

Standardized evaluation of visibility under all conditions is continuously indicated and recorded, using 350,000-cp fixed light source up to 4,000 feet from monitoring phototube connected to pulse generator whose output frequency varies with intensity of incident light after passage through atmosphere

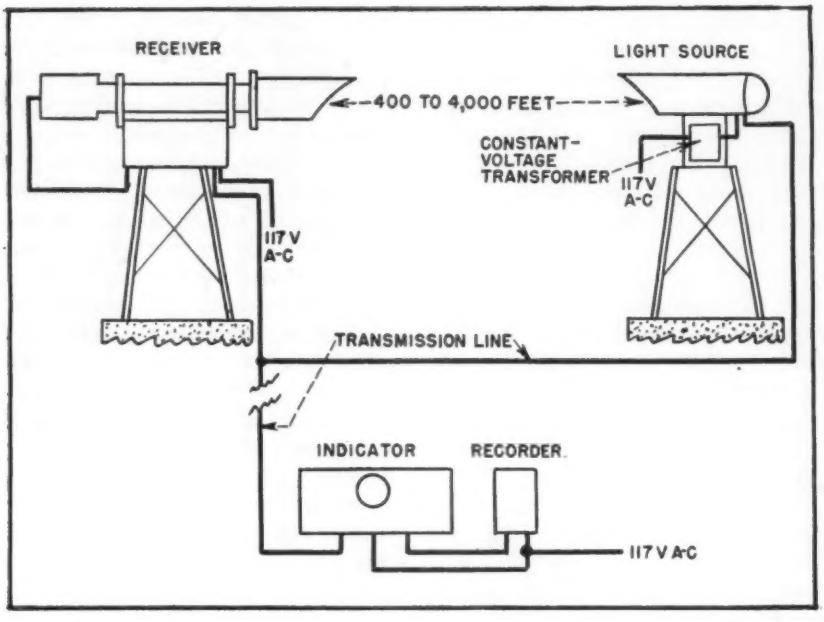
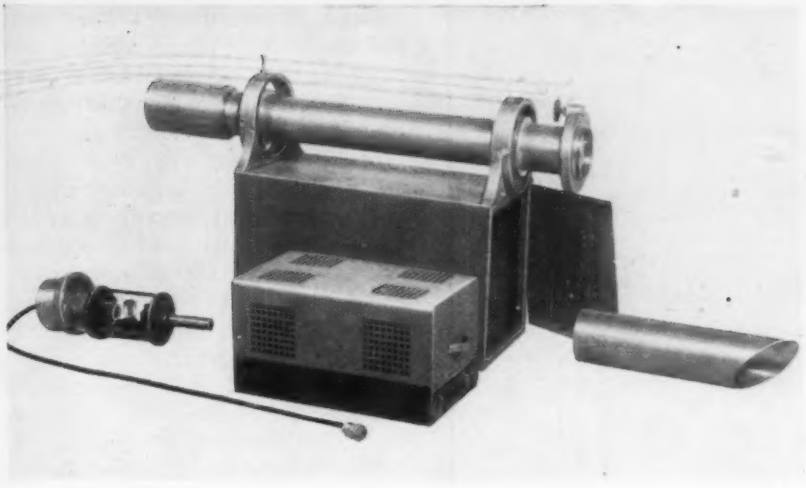


FIG. 1—Arrangement of transmissometer components. The indicator and recorder can be placed anywhere within ten miles of light source and receiver

IN EVERY FULL-SCALE TEST of the effectiveness of a concealment measure or of the visibility of a light signal, the light transmission of the atmosphere is a vital element. Frequently the transmission varies so rapidly that the effects of all other variables, including those under study, are obscured. Many thousands of man-hours have been wasted in visibility tests by attempts to take account of atmospheric transmission merely by visual estimates stated in such terms as foggy, hazy, or clear. At present, visibility data in the proximity of airports—so important in safe aircraft operation—is obtained by such periodic visual observation.

To eliminate or reduce the human factor in visual estimation, particularly in foggy weather, the National Bureau of Standards has developed an electronic instrument,



The 350,000-candlepower light source, voltage-regulating transformer, and clock that shuts off the light for calibration purposes once an hour

Transmissometer

AVIATION APPLICATIONS

PRINCIPAL APPLICATIONS of this transmissometer to aviation are to:

Supplement periodic visual observations by a continuous record;

Record the variations and rate of change of conditions of visual range;

Replace visual observations where trained observers or satisfactory marks, especially lights, are not available;

Provide a more accurate indication of visual range over a restricted area remote from an observer, particularly an approach zone;

Provide more accurate indications of visual ranges when visibility becomes poor.

the transmissometer, which measures accurately and continuously the light transmission between two fixed points.

The transmissometer consists of a light source, a phototube receiver, an amplifier and an indicator, shown in Fig. 1. The distance between the light source and receiver may be varied, depending on the particular application; distances up to 4,000 feet have been used. The amount of light falling on the receiver from the constant-intensity light source is determined by the haze or fog density between the two points. The output of the receiver is transmitted to the indicator, which may be placed at a control station as much as several miles from the light source and receiver.

A 6-volt sealed-reflector lamp constitutes the 350,000-candlepower light source, which differs from a sealed-beam headlight only in its cover and filament. The intensity of the light is closely controlled by a voltage-regulating transformer, insuring a light output substantially independent of line voltage. Adjustments of the intensity are made by means of a series rheostat. For a zero check of the transmissometer the light is turned off automatically once an hour, while intermediate zero checks may be made by the operator from the indicator several miles away. Burning continuously, the lamp has an expected service life of three to six months.

The Light Receiver

The transmissometer receiver consists of a lens, a diaphragm, a photo-pulse unit and an amplifier. Light from the source, focused by the lens on a pinhole in the diaphragm, falls on the phototube receiver and there generates pulses whose frequency is directly proportional to the intensity of light incident on the phototube. These pulses are amplified and transmitted over a signal line to the indicator.

The pulse generator circuit is shown in Fig. 2. Phototube current charges capacitor C_1 until the voltage across it is sufficient to initiate a discharge through the neon lamp. The capacitor then rapidly discharges through the neon lamp and resistor R_3 until the voltage across the neon lamp is no longer sufficient to maintain a current through the lamp. During discharge the voltage drop across R_3 supplies a voltage pulse to the grid of the 6J5 tube which causes a momentary change in the plate current of the tube. The resulting momentary change in voltage drop across transformer T_1, when amplified, supplies the pulse signal that is transmitted to the indicator.

The time required to produce a given change in the voltage across C_1 varies inversely with the current through the phototube. Therefore, the degree to which the pulse rate is proportional to the light incident on the phototube depends on the following factors: the degree of proportionality between the phototube current and the light flux incident upon its cathode; the leakage currents across the components shunting C_1; the constancy of the drop in voltage across C_1 for each discharge; the degree to which the time of discharging is negligible as compared to that of charging the capacitor.

The characteristic of the type 929 phototube is such that, if the voltage across it is greater than 20 volts, the current is nearly proportional to the incident light flux falling on the cathode. The minimum phototube voltage is the difference between 105 volts (the

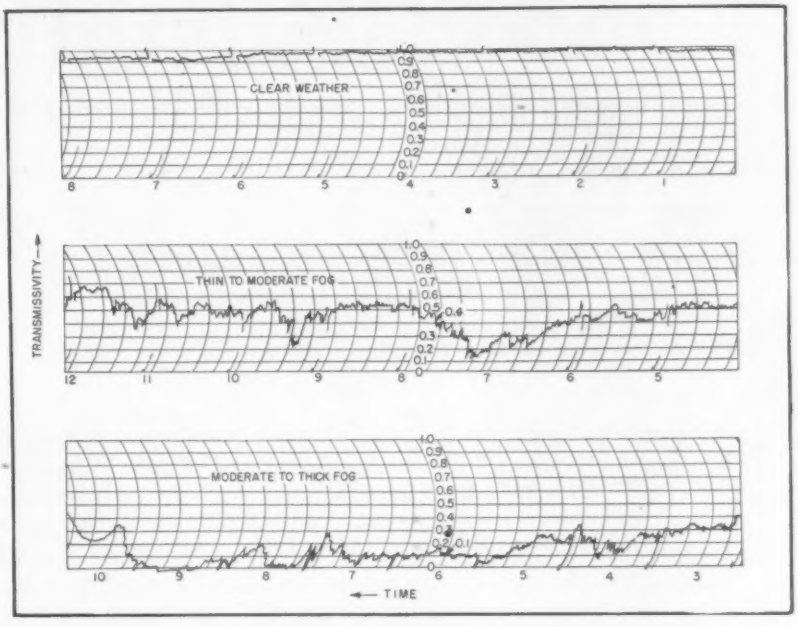
transmission line. The amplifier also limits to a satisfactory value the maximum strength of the pulses applied to the grid of the type 2050 tube.

The input pulse triggers the 2050 tube, which charges capacitor C_5. Capacitor C_4, which supplies part of the momentary current through the tube, serves also to quench this current. As long as the strength of the pulse applied to the grid is sufficient to trigger the 2050 tube, the charge flowing into C_5 for each pulse is independent of the magnitude of the pulse. When the pulse rate is constant, the voltage across C_5 assumes a constant value which is proportional to the number of pulses per second.

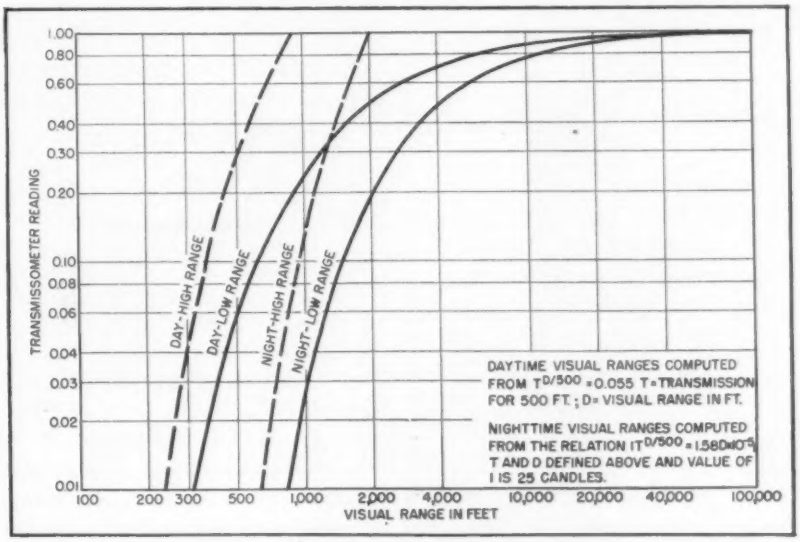
The bridge circuit shown in Fig. 3 is essentially a vacuum-tube voltmeter which indicates the voltage across C_5. Because of the voltage characteristics of the VR tubes, the current in the resistance arms of the bridge must remain substantially constant. A change in grid potential, with resulting change in the plate current of the 6J5 tube, is accompanied by an equal and opposite change in the current through the VR105 tube. The meter, therefore, measures the change in plate current of the 6J5 tube produced by a change in grid potential. As this change is a function of the voltage across capacitor C_5, it is determined by the pulse rate. When no signal is on the grid of the 6J5 tube, the grid bias of the tube is adjusted so that current does not flow through the meter. The meter reading is, therefore, directly proportional to the pulse rate of the input signal.

The type 6H6 tube and the neon lamp form a pulse generator which produces pulses of the same frequency as that of the input power line. When the indicator is being calibrated, the pulses from the calibrator are applied to the grid of the 2050 tube through the amplifier. Since the indicator is designed for use with 60-cycle power, the calibration frequency is 60 pulses per second. Hence, when the indicator is properly calibrated, a full-scale reading on the low range requires 60 pulses per second, and on the high range 12 pulses per second.

Indicator and recorder for converting pulse signals to a meter reading or permanent record. This unit can be remotely located from transmitter-receiver equipment



Representative records taken during clear weather, moderate, and thick fog. The time scale reads from right to left


TRANSMISSOMETER READING
VISUAL RANGE IN FEET
DAY-HIGH RANGE
DAY-LOW RANGE
NIGHT-HIGH RANGE
NIGHT-LOW RANGE
DAYTIME VISUAL RANGES COMPUTED FROM $T^{D/500}=0.055$ T=TRANSMISSION FOR 500 FT.; D= VISUAL RANGE IN FT.
NIGHTTIME VISUAL RANGES COMPUTED FROM THE RELATION $IT^{D/500}=1.580\times10^{-5}$ T AND D DEFINED ABOVE AND VALUE OF I IS 25 CANDLES.

A chart used to convert transmissometer readings to a scale of visibility. The chart is based on a 500-foot range, but the visual range is extrapolated beyond this distance. Two range positions were available in the equipment used

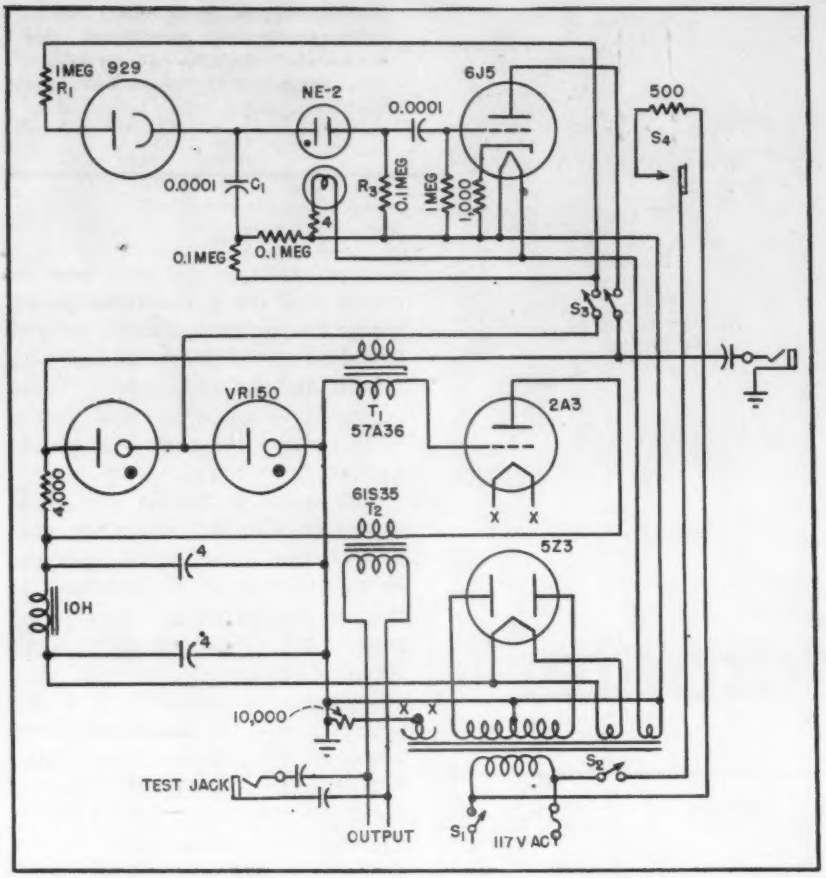


FIG. 2—Circuit diagram of the phototube receiver and pulse circuit that indicates received light intensity. The lefthand voltage regulator tube is type VR105

voltage across tube VR-105) and the breakdown voltage of the neon lamp plus the drop across resistor R_1. The maximum phototube current—less than 1 microampere—gives a drop across R_1 lower than 0.1 volt. Since the breakdown voltage of the neon lamp is approximately 80 volts, the minimum voltage across the phototube is about 25 volts. Ceresin wax is used to insulate the component parts shunting the high leakage resistance capacitor C_1 in order to reduce the leakage current, the total of which is less than 10^{-10} ampere.

The constancy of the drop in voltage across C_1 for each discharge depends upon the behavior of the neon lamp. Since this behavior is erratic unless subjected to some incident light, an incandescent filament lamp (Fig. 2) is provided whose light intensity is adjusted to the minimum necessary for consistent operation. More light than this minimum increases the leakage current through the neon lamp when it is not discharging. The minimum charging time used in the field is 0.02 second, while the estimated time of discharge is about 0.00001 second. It is evident, therefore, that the departure from linearity should be small.

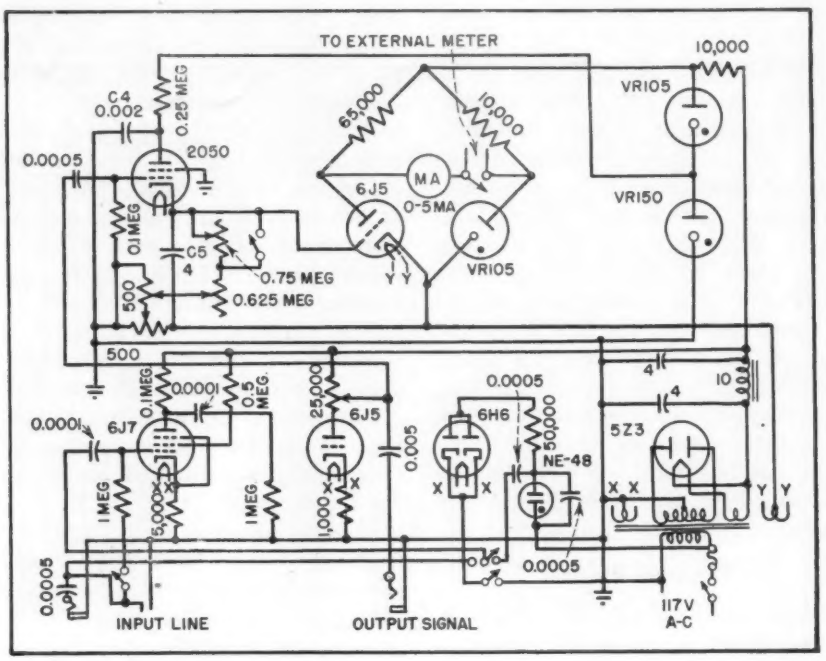


FIG. 3—Circuit diagram of the indicator, comprising a two-stage amplifier and frequency-measuring bridge circuit. The type 6H6 and neon tubes are a part of the 60-pps calibration circuit

The Indicator

The indicator, a circuit diagram for which is shown in Fig. 3, consists of a two-stage amplifier, a frequency-measuring unit, and a calibrator which provides a calibration frequency of 60 pulses per second. The frequency meter levels and averages the pulses, sharpened and amplified by the amplifier, and produces a meter reading which is directly proportional to the pulse frequency and thus to the transmission of the atmosphere between the light source and the receiver. The visibility of objects or lights is a function of the atmospheric transmission. If the atmosphere is homogeneous, the maximum distance at which objects or lights can be seen can be determined from the transmissometer readings.

The two-stage amplifier, consisting of a type 6J7 and a type 6J5 tube, amplifies and sharpens the incoming pulses and reduces the effects of noise picked up on the

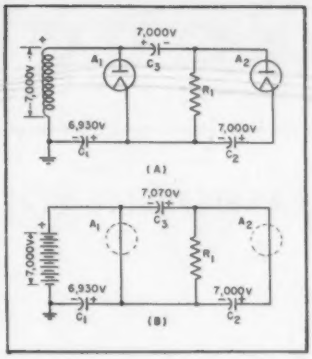


FIG. 3—The diodes act to transfer charges from capacitor to capacitor

L_P	A_1	A_2	C_1	C_2	C_3	R_1	R_L
			Beginning of trace (t_1)				
−700	−7,700	−7,700	+7,000	+7,000	+7,000	−700	+14,000
			Ending of trace (t_2)				
0	−6,930	−6,860	+6,930	<7,000	+7,070	−560	+13,930
			Beginning of retrace (t_3)				
+7,000	+70	+70	+6,930	<7,000	+7,070	+7,070	+13,930
			Ending of retrace (t_4)				
0	−7,000	−7,000	+7,000	+7,000	+7,000	0	+14,000

Polarities of capacitor voltages as shown in Fig. 1C; for others, positive is at top. Times are indicated in Fig. 1A. All voltages approximate.

Table 1—Voltages Across Components During Operating Cycle

for Television Receivers

By I. G. MALOFF

RCA Victor Division
Radio Corporation of America
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through the resistor is of the order of one percent. In other words, the circuit elements tend to come to the same potentials as those given for the beginning of the trace, because the transformer quickly brings the potential of C_1 to the initial 7,000 volts.

The remarkable thing about a cascading pulse rectifier is that the circuit elements have to stand only a few volts more across their terminals than the d-c output voltage per stage as summarized in Table I. Output capacitors C_1 and C_2 have on their terminals only the d-c output voltage per stage plus the ripple, which is of the order of one percent. Coupling capacitor C_3 has only the d-c output voltage per stage plus a small boost in voltage during trace; resistor R_1 has 10 percent of the output voltage per stage on trace and about 101 per cent of it on retrace. The peak inverse voltage on the rectifier tubes is only 10 percent higher than the d-c output voltage per stage. (Of course, some components have to withstand the total output voltage between high terminal and ground.)

The above analysis is very elementary but is sufficient to explain the operation of the circuit, which may be summarized as follows: During trace, the coupling capacitors are charged through the resistors to a voltage slightly higher than the d-c voltage per stage; during retrace this excess voltage is transferred to the filter capacitors, except for the first stage which is directly charged by the transformer.

High-voltage rectifier tube, like other components of pulsed television receiver rectifier, is subjected to only the peak voltage per cascaded section, not to the total output voltage

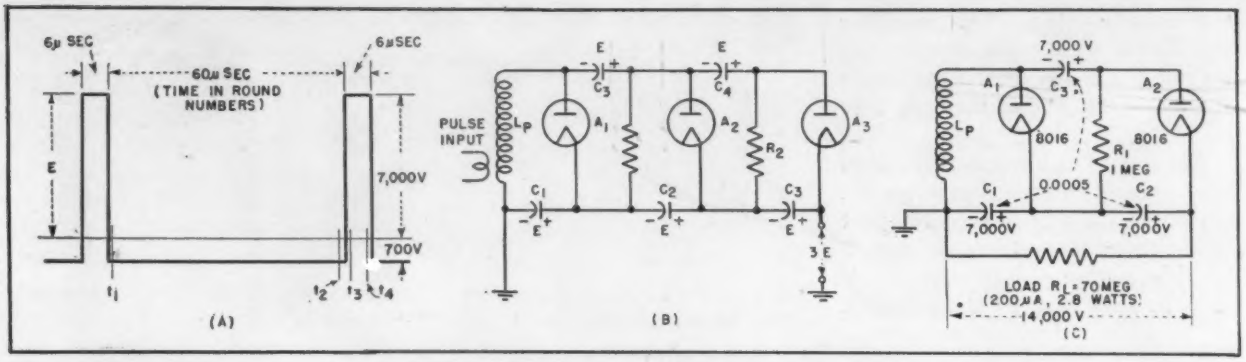


FIG. 1—(A) Pulse delivered by television receiver sweep circuit to rectifier has this idealized waveshape. (B) Pulsed cascade rectifier consists of sequence of diodes charging capacitors in cascade. (C) A typical and simple type of cascade rectifier consists of two sections with a load across the output

Pulsed Rectifiers

Brief analysis of pulsed cascade rectifiers used in television receivers indicates that no component is subjected to potentials substantially higher than those encountered per section. In a doubler, this voltage is about half the output voltage from the rectifier

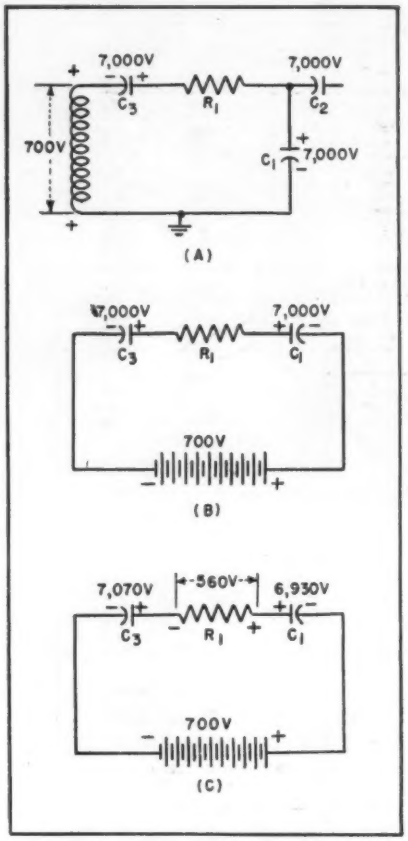


FIG. 2—During the operating cycle, voltages are redistributed about the rectifier. To simplify analysing the action of the pulsed circuit, the input transformer is replaced by a battery

TO OBTAIN HIGH VOLTAGES for cathode-ray tubes of television receivers, the pulse produced by flyback of the scanning generator is used to excite a step-up transformer. Under ideal conditions with present television standards, the transformer will deliver a voltage having a waveshape shown in Fig. 1A. The high voltage so developed is usually rectified by cascaded diodes charging a series of capacitors connected as shown in Fig. 1B. To determine ratings for circuit components, it is necessary to first examine circuit operation to ascertain their respective functions.

Circuit Operation

For analysis, let us consider the simplest pulsed cascade rectifier, the doubler, a schematic diagram of which is shown in Fig. 1C. The time constant of the output circuit, ignoring C_3, is $T_o = R_L(C/2) = 0.0175$ sec or approximately 300 times the duration of the trace. Therefore, except for regulation, operation of the circuit is unaffected by the load R_L.

During the trace the circuit can be represented as in Fig. 2A and 2B. The drop across R_1 (Fig. 2B) is the full battery voltage at the start of the trace. The time constant of the above circuit for $R_1 = 10^6$ ohms is $R_1(C/2) = 250$ microseconds, which means that in 60 microseconds (trace duration) the battery will change the potential on the two capacitors by 20 percent of the battery voltage, or 70 volts per capacitor. At the end of the trace, therefore, the voltages in the active part of the circuit change to those shown in Fig. 2C.

On retrace, a voltage of 7,000 volts is suddenly applied in the reverse direction by the transformer winding as at Fig. 3A. Rectifier A_1 starts conducting, in effect connecting C_1 across the high-voltage transformer secondary as at Fig. 3B. It also connects C_3 across R_1, thereby isolating the two circuits.

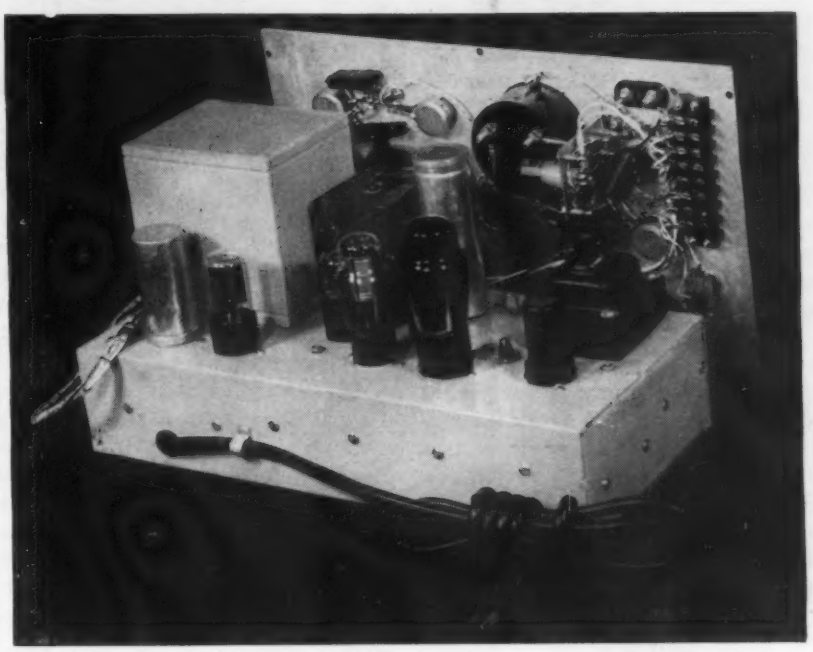
Rectifier A_2, being between C_2 and C_3, has 70 volts more on its plate than on its filament; therefore, it tends to equalize the charges on C_2 and C_3 while the full voltage of C_3 is impressed across R_L. The time constant of this discharge circuit being $R_LC_3 = 500$ microseconds (or approximately 80 times longer than the retrace), the loss of charge

Sweeping Oscillator

Single test oscillator covers all frequencies from upper video range through standard a-m broadcast, police, aeronautical, f-m broadcast, and television bands to the citizen's band. Basically the circuit is a beat-frequency oscillator using two 3-cm klystrons

or variation of any of the receiver parameters on the response at all frequencies is immediately apparent. The possibility of missing a hump or some other asymmetry in the response is eliminated, as the output of the sweeping oscillator has no discontinuities within its particular spectrum.

Calibration of the frequency coordinate of the receiver response frequency plot on the oscilloscope screen is most conveniently accomplished by means of the precision absorption type wavemeter. When the sweeping oscillator passes through the frequency to which the wavemeter is set, there will be a dip in the response pattern, thus effecting the calibration.



Microwave parts are thoroughly shielded; regulated power supply is essential to the frequency stability of the klystron oscillators

Oscillator Components

Figure 1 gives the block diagram of the sweeping oscillator, which is a heterodyne-type generator combining the outputs of two X-band (3-cm) reflex klystrons (the Sheppard-Pierce type) in a mixing network. One klystron, called the signal generator, is at a fixed frequency during operation of the instrument. The other, designated the local oscillator, is swept in frequency by the application of a sawtooth wave to its repeller. The two outputs are heterodyned in a microwave crystal mixer and the resulting difference frequency made available at the output terminals.

The sawtooth is generated by a gas tube relaxation oscillator and serves not only to modulate the local oscillator but also to develop sweep voltage for use in synchronization of an oscilloscope sweep. An efficient electronically regulated power supply furnishes plus 300 volts, minus 300 volts (both regulated), and filament power. Ripple is kept very low so as to obtain stable klystron operation.

Sweeping Oscillator

Figure 2 shows the simplified schematic diagram of the sweeping oscillator. All adjustments are available at the front panel. The sawtooth sweep voltage generator is a conventional gas tube relaxation oscillator utilizing the miniature 2D21 gas tetrode. The sweep rate control varies the capacitor charging time-constant to make available sweep rates from approximately 50 to 100 cps. The sweep amplitude control adjusts the output frequency excursion up to a maximum of 40 mc by controlling the magnitude of the sawtooth voltage applied to the local klystron oscillator repeller electrode. The use of this adjustable relaxation oscillator for the production of both frequency and oscilloscope sweep has not only added to the flexibility of the system, but has also eliminated the inconvenient phasing adjustments necessary when the line supply voltage is used for the same purpose.

It is also possible to frequency modulate the klystron from an external source by removing the 2D21 and feeding the external modulating signal into the instrument through the sweep output jacks.

Reflex Klystron Characteristics

The literature is sufficiently rich in klystron references to make any detailed review of klystron theory inappropriate. However, maximum efficiency in the utilization of this

Wide-Range

By ENGINEERING STAFF
Kay Electric Co.
Newark, N. J.

Controls for frequency tuning and sweep adjustment are on front panel of the wide-range sweeping oscillator. There is also a precision tunable resonant cavity for frequency measurement

EXPANSION of the commercially useful electromagnetic frequency spectrum, accelerated by wartime developments, has made an extremely wideband sweeping oscillator a laboratory necessity. For example, the maintenance man alternately faced with servicing a standard a-m broadcast receiver and next a television receiver needs an oscillator covering a wider frequency range than provided from previously available signal generators. The research worker needs a laboratory instrument covering an even greater frequency spread.

To meet a need for such test equipment a wide-range sweeping oscillator has been developed. It has output frequencies between 50 kc and 500 mc immediately available at approximately a 50-ohm impedance level and with an amplitude of about 0.1 volt maximum.

Receiver Alignment

Frequency excursion per sweep is adjustable to a maximum of approximately 40 mc. A sawtooth sweep voltage adjustable between 50 and 100 cps is available at front panel terminals to be used either as such or as a synchronizing source for another sweep generator. A precision coaxial wavemeter is included with the front panel controls. Thus the sweeping oscillator in combination with any cathode-ray oscilloscope provides a receiver alignment tool that is at once precise and extremely flexible. For example, a television or f-m broadcast receiver can be aligned with equal ease.

In aligning a receiver, the sweeping oscillator produces a signal of nearly constant amplitude but with a cyclic time variation in frequency. A sweep voltage whose amplitude variation is synchronized with the signal frequency variation is also furnished by the sweeping oscillator. With the frequency excursion approximately centered in the passband of the receiver, the vertical amplifier of the oscilloscope is connected to some convenient monitoring point in the audio or video section of the receiver. The sawtooth sweep voltage output available at the oscillator is connected to the horizontal amplifier of the oscilloscope, or the internal sweep of the oscilloscope, properly synchronized, is used. The pattern on the screen is a graph whose abscissa is frequency and whose ordinate is receiver response.

This method of alignment is more rapid than the point-by-point technique. What is usually more important, the effect of the adjustment

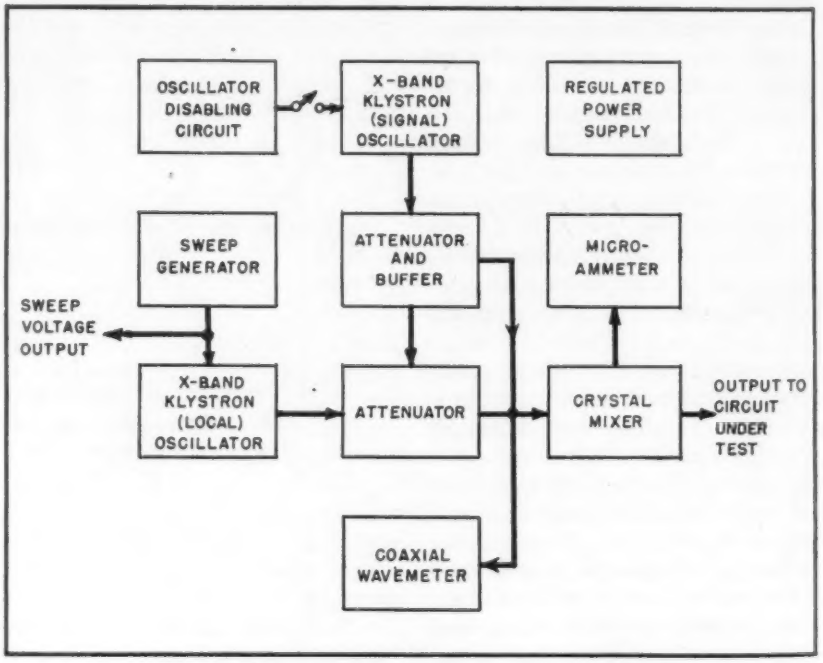


FIG. 1—Block diagram shows principle of operation

is attenuated more in passing through the directional coupler. Hence, adjustment of the transmitted amplitude of the signal oscillator controls the output of the sweeping oscillator. This arrangement also prevents the previously mentioned amplitude modulation of the local oscillator signal, associated with the frequency modulating process, from appearing in the output. With the signal oscillator producing an output of constant amplitude, the output of this instrument is therefore substantially independent of variations in the amplitude of the local oscillator.

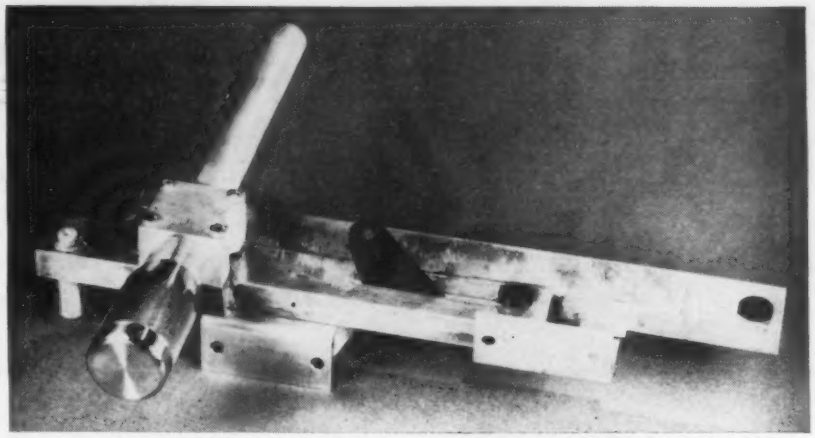


FIG. 4—Directional couple minimizes pulling between klystrons; tunable cavity provides frequency calibration

Frequency Calibrating Circuit

The frequency calibrating circuit of this instrument is built around a precision coaxial absorption wavemeter. The outer conductor of the coaxial line is silver plated on its inner surface, and the moveable center conductor is an invar rod successively copper, nickel, and silver plated. This type of construction, together with close mechanical tolerances, insures high Q, negligible temperature coefficient, and high overall precision.

The crystal current indicated on the microammeter is a function of the rectified output of both the local and signal oscillators. Normally, however, the highly attenuated signal of the signal oscillator contributes a negligible amount to the total crystal current. Hence in order to monitor the output or measure the frequency of the signal oscillator it is necessary to deactivate the local oscillator and increase the meter sensitivity by a pushbutton switch on the front panel.

In the operation of this instrument, a reading proportional to the local oscillator frequency is taken and recorded, with the sweep amplitude at zero. The pushbutton is then depressed, and a reading is taken of the frequency of the signal oscillator. The output frequency is then the difference multiplied by a proportionality factor.

After the oscilloscope pattern is properly located and centered appropriately to the equipment under test, the calibration of the frequency axis of this pattern is accomplished by first recording the wavemeter reading proportional to the wavelength of the signal oscillator. This measurement involves tuning the wavemeter until the entire visible pattern decreases. The wavemeter is then varied until a moveable dip is seen on the pattern. The movable dip is an indication of the frequency of the local oscillator and is used to measure the width of the passband and, in conjunction with the signal oscillator reading, the absolute frequency. This procedure eliminates the use of any switching.

The midpoint of the frequency excursion can be readily adjusted to a maximum of 500 mc. This limit is not imposed by the frequency range of the two klystrons. Indeed, if only the range of the two oscillators were considered, a maximum midpoint frequency of nearly 1,000 mc could be reached. This last figure arises from the fact that each oscillator has a frequency range of about 1,000 mc, covering the band 8,700 to 9,700 mc. The upper frequency limitation of the instrument is determined by the properties of the output circuit. Much above 500 mc, the unavoidable capacitances in the crystal mixer output circuit take their toll and the output amplitudes fall off. If, however, a coaxial output circuit is used, it is possible to push the frequency limit up another octave to 1,000 mc.

The sweep amplitude adjustment gives continuous control of the frequency excursion per sweep from zero up to a maximum of 40 mc. This large frequency excursion, together with the frequency coverage, gives ample and flexible coverage for most if not all commercial vhf applications, including color television.

With the local oscillator sweeping a frequency range that just or nearly includes the constant frequency of the signal oscillator, it is possible to obtain output frequencies close to the audio range. Ideally, of course, the complete audio band could be covered. This is not practically feasible, however, because even with a carefully designed waveguide system there is some pulling or interaction between the two oscillators when their frequencies are close. This interaction can be ascribed to the small departure of the waveguide terminations and crystal mixer assembly from the ideal flat waveband loading. It is this pulling which limits the low end of the frequency range.

In addition to the use of the sweeping oscillator as an aligning instrument, it is also possible to utilize the oscillator without the sweeping feature by the simple expedient of turning off the sweep amplitude. This instrument so operated becomes a c-w signal source with the above-mentioned ranges.

This instrument is well suited for instructional purposes as it produces visual indications of the frequency characteristics of receivers and transducers when used in conjunction with a suitable oscilloscope.

No complete attempt to enumerate the capabilities of this instrument has been made. It is the opinion of the designers that this instrument is intrinsically so flexible that numerous additional uses will suggest themselves to the user.

sweeping oscillator requires that certain klystron characteristics be kept clearly in mind. Figure 3 gives two plots, both against the magnitude of negative repeller voltage, as the abscissa (repeller voltage increasing in negative value to the right); one graph is with output as the ordinate, the other with frequency as the ordinate.

The plot of output against repeller voltage indicates that oscillations can be sustained over certain ranges of repeller voltages. Note that the average magnitude of the output over the two ranges shown is greater for the higher repeller voltage. The mode with the greater output, as would be expected, is associated with the lesser time of the electron bunches in the space between the bunching grids and the repeller. The two voltage modes are only representative; there may be more or fewer depending on the electrode voltages obtainable.

The plot of repeller voltage against frequency illustrates the frequency sweeping principle of this instrument. If the repeller voltage is varied over a range within the limits imposed by a voltage mode, then the frequency of the local oscillator will vary in magnitude as well as frequency, as between points A and B of Fig. 3. This variation in magnitude might seem to introduce an unwanted amplitude modulation characteristic in the output. Actually such is not the case, for reasons to be mentioned in the next section.

The natural resonant frequency of the cavity of either klystron is not affected by the variation of the repeller voltage; such variation merely drives the cavity off resonance up to a limit imposed by the effective Q of the cavity. The actual resonant frequency is adjusted by changing the grid spacing and thus the physical conformation of the cavity. The grid spacing of either klystron can be changed, but only a control for the local oscillator is brought out to the front panel as the coarse tuner.

Mixing Oscillator Outputs

The principal design problem associated with mixing the outputs of the two oscillators in the waveguide system involved the efficient isolation of the oscillators from each other to minimize pulling. Furthermore, sufficient decoupling between the oscillators and their load was required. Figure 4 illustrates the waveguide system that was used. The chief feature of this system is the broadband directional coupler, which consists physically of three holes in the wall between the two waveguides.

Directional couplers are designed to provide transmission between two waveguides (or transmission lines) in one direction only. For this particular system, the directional coupler allows energy from the signal oscillator to reach the crystal mixer, but ideally no energy from this source reaches the local oscillator. Similarly a minimum amount of energy from the local oscillator reaches the signal oscillator. Transmission from one waveguide to the other is directed to the termination and is almost completely absorbed. Thus local and signal oscillators are isolated and the possibility of locking or pulling is minimized though not entirely eliminated, as later explained.

Signal from the signal oscillator undergoes about 10 db attenuation in passing through the directional coupler and, constrained by the one-way properties of the coupler, reaches only the crystal mixer assembly. There is little reflection of this particular signal in either of the waveguides because the crystal assembly is in the shorter waveguide, and a carbon coated termination card is in the other. Both provide loads of approximately the characteristic impedance of their waveguides. The signal from the local oscillator travels directly to the mixer. The portion of the signal from this source entering the longer waveguide by way of the three-hole coupler is directed only toward the termination, where it is completely absorbed.

The two attenuators shown in Fig. 4 have somewhat different purposes. The attenuator between local oscillator and mixer decouples this oscillator from its load. As a matter of fact, the attenuator action is incidental, the isolating action being the primary consideration. The attenuator in the signal oscillator path is actually the output attenuator; that is, its adjustment controls the amplitude of the output from the sweeping oscillator. This action is possible because the output of the sweeping oscillator results from the heterodyning of two signals, one much larger than the other; the heterodyned output amplitude is substantially independent of the larger. The smaller of the two signals at the mixer is that of the signal oscillator, as this one

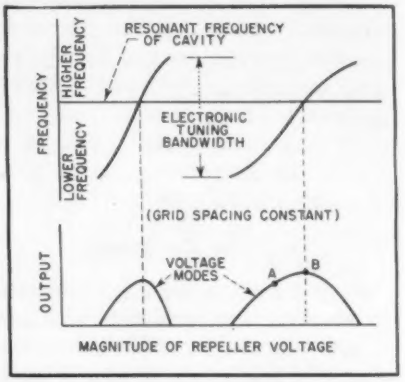


FIG. 3—Frequency and amplitude of klystron output are affected by varying its repeller voltage

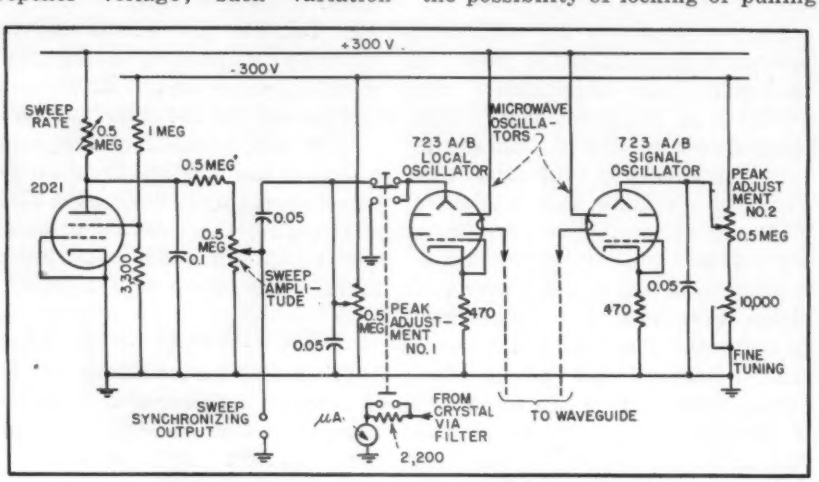


FIG. 2—Schematic of sweeping and tuning circuits

is attenuated more in passing through the directional coupler. Hence, adjustment of the transmitted amplitude of the signal oscillator controls the output of the sweeping oscillator. This arrangement also prevents the previously mentioned amplitude modulation of the local oscillator signal, associated with the frequency modulating process, from appearing in the output. With the signal oscillator producing an output of constant amplitude, the output of this instrument is therefore substantially independent of variations in the amplitude of the local oscillator.

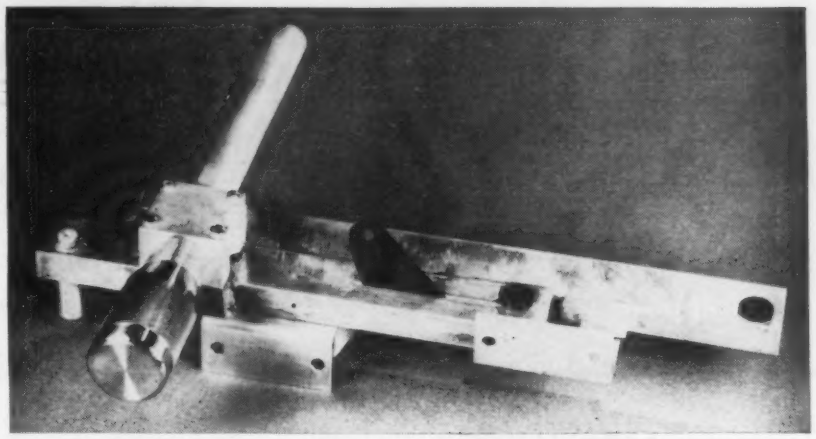


FIG. 4—Directional couple minimizes pulling between klystrons; tunable cavity provides frequency calibration

Frequency Calibrating Circuit

The frequency calibrating circuit of this instrument is built around a precision coaxial absorption wavemeter. The outer conductor of the coaxial line is silver plated on its inner surface, and the moveable center conductor is an invar rod successively copper, nickel, and silver plated. This type of construction, together with close mechanical tolerances, insures high Q, negligible temperature coefficient, and high overall precision.

The crystal current indicated on the microammeter is a function of the rectified output of both the local and signal oscillators. Normally, however, the highly attenuated signal of the signal oscillator contributes a negligible amount to the total crystal current. Hence in order to monitor the output or measure the frequency of the signal oscillator it is necessary to deactivate the local oscillator and increase the meter sensitivity by a pushbutton switch on the front panel.

In the operation of this instrument, a reading proportional to the local oscillator frequency is taken and recorded, with the sweep amplitude at zero. The pushbutton is then depressed, and a reading is taken of the frequency of the signal oscillator. The output frequency is then the difference multiplied by a proportionality factor.

After the oscilloscope pattern is properly located and centered appropriately to the equipment under test, the calibration of the frequency axis of this pattern is accomplished by first recording the wavemeter reading proportional to the wavelength of the signal oscillator. This measurement involves tuning the wavemeter until the entire visible pattern decreases. The wavemeter is then varied until a moveable dip is seen on the pattern. The movable dip is an indication of the frequency of the local oscillator and is used to measure the width of the passband and, in conjunction with the signal oscillator reading, the absolute frequency. This procedure eliminates the use of any switching.

The midpoint of the frequency excursion can be readily adjusted to a maximum of 500 mc. This limit is not imposed by the frequency range of the two klystrons. Indeed, if only the range of the two oscillators were considered, a maximum midpoint frequency of nearly 1,000 mc could be reached. This last figure arises from the fact that each oscillator has a frequency range of about 1,000 mc, covering the band 8,700 to 9,700 mc. The upper frequency limitation of the instrument is determined by the properties of the output circuit. Much above 500 mc, the unavoidable capacitances in the crystal mixer output circuit take their toll and the output amplitudes fall off. If, however, a coaxial output circuit is used, it is possible to push the frequency limit up another octave to 1,000 mc.

The sweep amplitude adjustment gives continuous control of the frequency excursion per sweep from zero up to a maximum of 40 mc. This large frequency excursion, together with the frequency coverage, gives ample and flexible coverage for most if not all commercial vhf applications, including color television.

With the local oscillator sweeping a frequency range that just or nearly includes the constant frequency of the signal oscillator, it is possible to obtain output frequencies close to the audio range. Ideally, of course, the complete audio band could be covered. This is not practically feasible, however, because even with a carefully designed waveguide system there is some pulling or interaction between the two oscillators when their frequencies are close. This interaction can be ascribed to the small departure of the waveguide terminations and crystal mixer assembly from the ideal flat waveband loading. It is this pulling which limits the low end of the frequency range.

In addition to the use of the sweeping oscillator as an aligning instrument, it is also possible to utilize the oscillator without the sweeping feature by the simple expedient of turning off the sweep amplitude. This instrument so operated becomes a c-w signal source with the above-mentioned ranges.

This instrument is well suited for instructional purposes as it produces visual indications of the frequency characteristics of receivers and transducers when used in conjunction with a suitable oscilloscope.

No complete attempt to enumerate the capabilities of this instrument has been made. It is the opinion of the designers that this instrument is intrinsically so flexible that numerous additional uses will suggest themselves to the user.

sweeping oscillator requires that certain klystron characteristics be kept clearly in mind. Figure 3 gives two plots, both against the magnitude of negative repeller voltage, as the abscissa (repeller voltage increasing in negative value to the right); one graph is with output as the ordinate, the other with frequency as the ordinate.

The plot of output against repeller voltage indicates that oscillations can be sustained over certain ranges of repeller voltages. Note that the average magnitude of the output over the two ranges shown is greater for the higher repeller voltage. The mode with the greater output, as would be expected, is associated with the lesser time of the electron bunches in the space between the bunching grids and the repeller. The two voltage modes are only representative; there may be more or fewer depending on the electrode voltages obtainable.

The plot of repeller voltage against frequency illustrates the frequency sweeping principle of this instrument. If the repeller voltage is varied over a range within the limits imposed by a voltage mode, then the frequency of the local oscillator will vary in magnitude as well as frequency, as between points A and B of Fig. 3. This variation in magnitude might seem to introduce an unwanted amplitude modulation characteristic in the output. Actually such is not the case, for reasons to be mentioned in the next section.

The natural resonant frequency of the cavity of either klystron is not affected by the variation of the repeller voltage; such variation merely drives the cavity off resonance up to a limit imposed by the effective Q of the cavity. The actual resonant frequency is adjusted by changing the grid spacing and thus the physical conformation of the cavity. The grid spacing of either klystron can be changed, but only a control for the local oscillator is brought out to the front panel as the coarse tuner.

Mixing Oscillator Outputs

The principal design problem associated with mixing the outputs of the two oscillators in the waveguide system involved the efficient isolation of the oscillators from each other to minimize pulling. Furthermore, sufficient decoupling between the oscillators and their load was required. Figure 4 illustrates the waveguide system that was used. The chief feature of this system is the broadband directional coupler, which consists physically of three holes in the wall between the two waveguides.

Directional couplers are designed to provide transmission between two waveguides (or transmission lines) in one direction only. For this particular system, the directional coupler allows energy from the signal oscillator to reach the crystal mixer, but ideally no energy from this source reaches the local oscillator. Similarly a minimum amount of energy from the local oscillator reaches the signal oscillator. Transmission from one waveguide to the other is directed to the termination and is almost completely absorbed. Thus local and signal oscillators are isolated and the possibility of locking or pulling is minimized though not entirely eliminated, as later explained.

Signal from the signal oscillator undergoes about 10 db attenuation in passing through the directional coupler and, constrained by the one-way properties of the coupler, reaches only the crystal mixer assembly. There is little reflection of this particular signal in either of the waveguides because the crystal assembly is in the shorter waveguide, and a carbon coated termination card is in the other. Both provide loads of approximately the characteristic impedance of their waveguides. The signal from the local oscillator travels directly to the mixer. The portion of the signal from this source entering the longer waveguide by way of the three-hole coupler is directed only toward the termination, where it is completely absorbed.

The two attenuators shown in Fig. 4 have somewhat different purposes. The attenuator between local oscillator and mixer decouples this oscillator from its load. As a matter of fact, the attenuator action is incidental, the isolating action being the primary consideration. The attenuator in the signal oscillator path is actually the output attenuator; that is, its adjustment controls the amplitude of the output from the sweeping oscillator. This action is possible because the output of the sweeping oscillator results from the heterodyning of two signals, one much larger than the other; the heterodyned output amplitude is substantially independent of the larger. The smaller of the two signals at the mixer is that of the signal oscillator, as this one

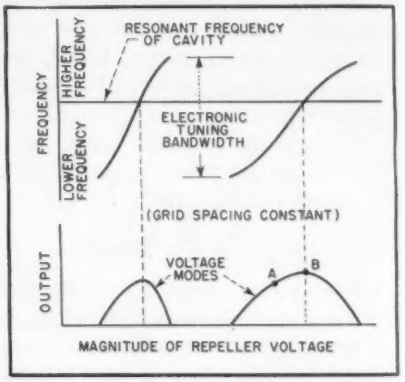


FIG. 3—Frequency and amplitude of klystron output are affected by varying its repeller voltage

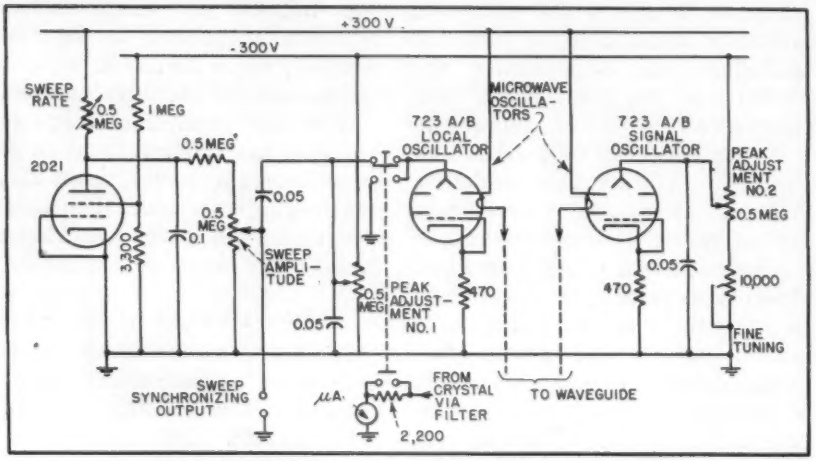


FIG. 2—Schematic of sweeping and tuning circuits

BEAM EVALUATOR

By H. LeCAINE and M. KATCHKY
Assistant Research Physicist *Junior Research Engineer*
National Research Council
Ottawa, Canada

Antenna tower and turntable used in harbor control installation at Halifax, Nova Scotia. The operating room is directly beneath the tower

pattern is made independent of fluctuations in transmitted power by an unusually simple method. The received signal is merely balanced against a monitor voltage. The recorder does not respond to, nor is it jammed by interference encountered around a radar establishment, and a high receiver sensitivity is realized without the necessity of using tuned amplifiers. These characteristics are achieved by using the pen motor in a synchronous detector circuit.

Arrangement of Equipment

All the equipment illustrated with the exception of the receiving antenna and its associated detector and amplifier, is located in a room under the antenna turntable. The block diagram of interconnections is shown in Fig. 1. Several receiving antennas for different bands and at various distances are available to increase the flexibility of the system, and all are remotely controlled from the recorder room. The receiving antennas have directional characteristics to reduce the influence of undesirable reflections.

In operation, modulated radio-frequency energy is transmitted from the test antenna, which is located on the turntable. As this antenna is rotated, the varying field strength at the receiver is used to control the movement of a pen which traces the pattern on a rotating drum geared to the turntable drive shaft.

Field-Strength Pattern

A power pattern of a high-gain antenna is not satisfactory because the side lobes are not given sufficient prominence. Field strength patterns overcome this objection and can be used directly to represent a contour of constant power or constant field strength. As the only suitable detectors give an output proportional to the power in the received signal, a direct-recording system with a linear potentiometer would give power patterns. To obtain the desired field strength patterns, a special attenuator could be used, but this would result in a recording sensitivity which varies with pen position. Since speed and accuracy place severe restrictions on the sensitivity, such a system would be satisfactory over a small range of signals only. In the circuit to be described, field strength patterns are obtained with constant recording sensitivity.

The transmitter most commonly used with the recorder is a klystron oscillator which is modulated by 90-cycle square waves from the multivibrator circuit shown in Fig. 2. The choice of 90 cycles was made to avoid power line frequency interference, and because there were no other users of 90-cycle frequency in the vicinity.

Part of the output from the multivibrator is amplified and applied to one field of the motor. A phase adjuster is provided to obtain the correct phase between the voltages on the two fields of the motor.

Receiving Equipment

The signal bolometer and amplifier are located near the receiving antenna. The bolometer is a Littelfuse element acting as a square-law detector. These elements have been in use for a number of years, and repeated tests by various methods and observers have proven them to be very accurately square-law up to several milliwatts. Thus the detected voltage is proportional to the radio-

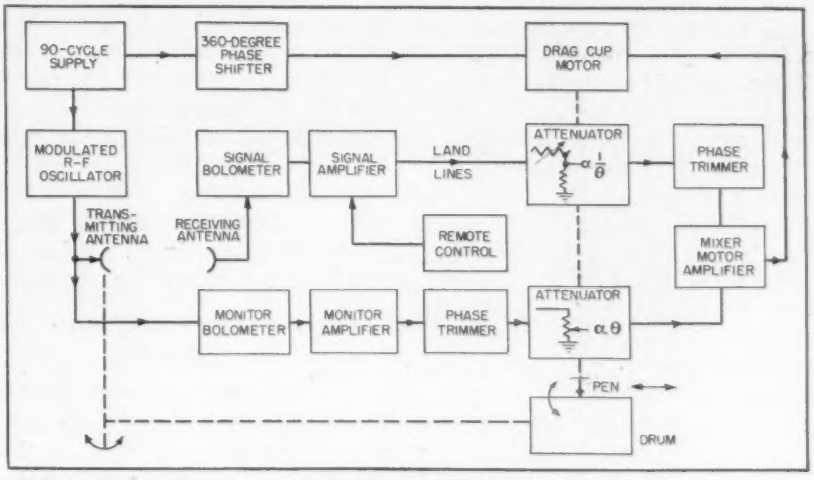


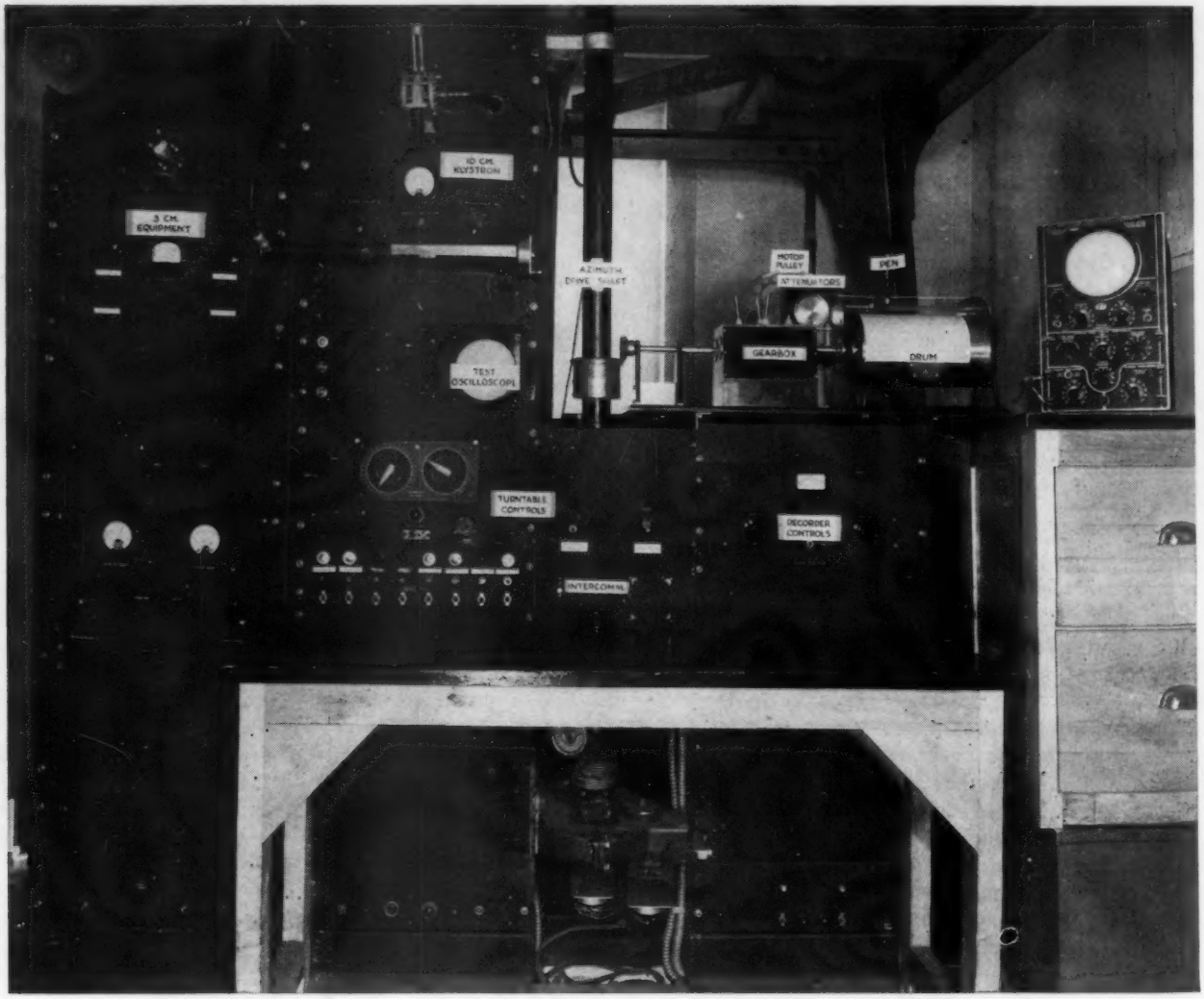
FIG. 1—Block diagram of the automatic recorder. Mechanical linkages between transmitting antenna and recording drum and between the attenuators and the recording pen are indicated by dashed lines

MICROWAVE ANTENNA

Development, adjustment, and routine maintenance of microwave antenna systems require a means for plotting the radiation pattern quickly. This system uses simple potentiometers but requires no nonlinear circuit elements. The recorded pattern is independent of transmitter power fluctuations and high sensitivity is realized without tuned amplifiers

IN THE DEVELOPMENT of high-gain microwave antennas, numerous radiation patterns are required when checking critical adjustments to feeds, radiators and reflectors before optimum conditions for beamwidth and side lobes are found. Manual pattern-taking is a slow, laborious process, as it is generally necessary to measure received or transmitted power at each of many angles, and to calculate and plot each pattern. To speed up this type of work, an automatic recorder was developed at the National Research Council of Canada, with some unique features.

Although the recorder plots the square root of the detected signal, only simple wire-wound potentiometers in which resistance varies linearly with angle are required. Furthermore, since no circuit elements with nonlinear amplitude characteristics are used, an accuracy of 1 percent in the trace is realized in daily operation. The



Main portion of the equipment located at the operating position. The antenna is mounted directly above and gain controls for the remote receiving antennas are easily accessible

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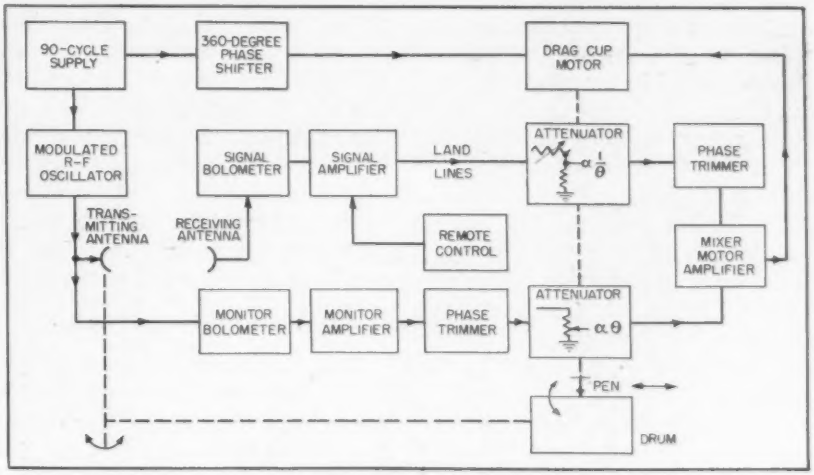

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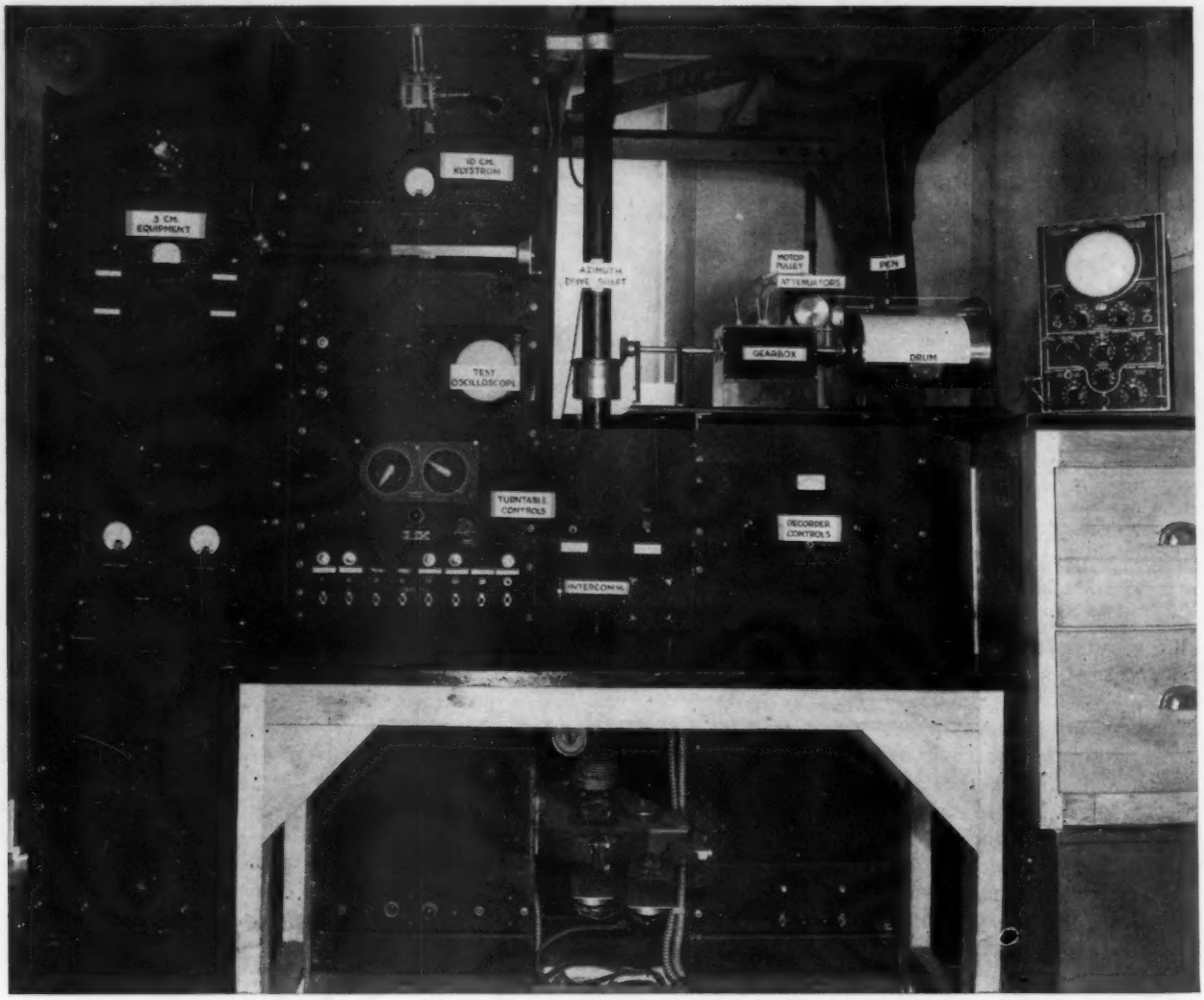

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At a given instant, the voltage applied to the motor is proportional to

$$V = E_m\theta - E_s/\theta$$

Taking the recording sensitivity S as being equal to the change in voltage per unit change in pen position, it is seen that

$$S = \frac{\partial V}{\partial \theta} = E_m + \frac{E_s}{\theta^2}$$

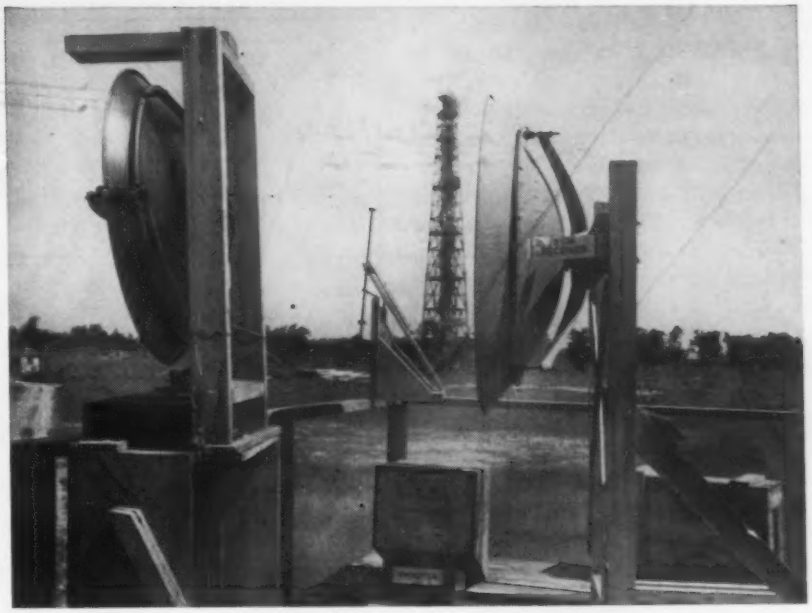
but

$$E_s/\theta^2 = E_m$$

therefore

$$S = 2\,E_m$$

Thus the sensitivity is independent of the pen position. It is however, proportional to the monitor voltage, but the fluctuations in output normally encountered do not produce significant changes in sensitivity.



One of several typical receiving stations located at a distance from the transmitting antenna. Gain of the amplifier (lower center) is remotely controlled from the operating position

Recording Circuits

The circuit diagram for the mixer and recording motor is shown in Fig. 4. Where it is necessary to have a transformer before the point where the two voltages are added, great care must be taken, as it is essential that there should be no change of phase with amplitude. The first stage is a signal amplifier with cathode feedback. Following this, the two voltages are added in a circuit containing only simple resistance. Phase trimmers are provided in both monitor and signal lines to obtain the correct phase relationship. The remaining stages amplify the difference voltage before it is applied to the motor. The gain is adjusted for optimum recording sensitivity after the monitor voltage has been set at the required value.

The recording motor is a small alternating-current drag cup motor which has two field windings on the stator surrounding a cup-shaped rotor. The rotating shaft drives the ganged attenuator contacts and also

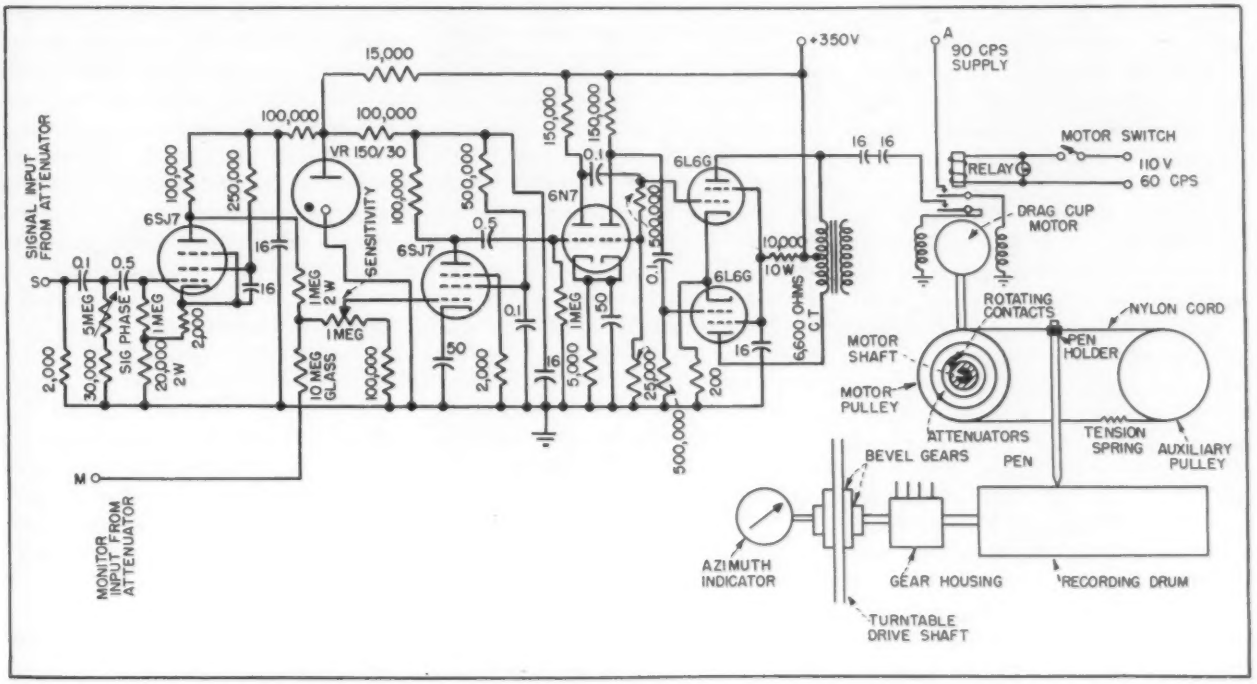


FIG. 4—The signal mixer, motor amplifier and recording apparatus are shown schematically and their interconnections to the other units are indicated

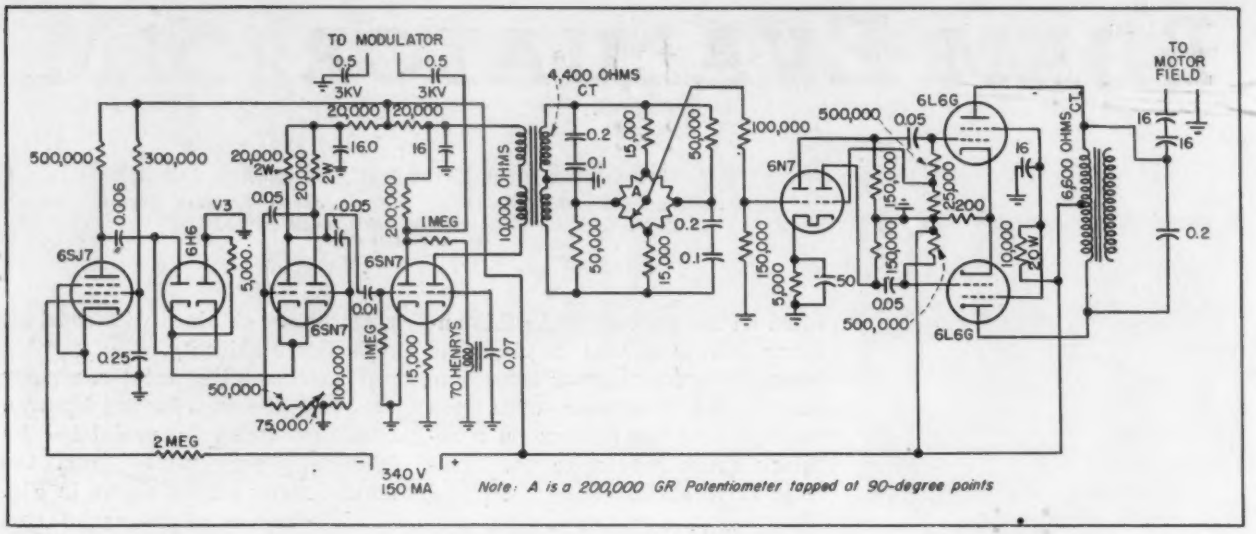


FIG. 2—The 90-cycle supply comprises a multivibrator circuit locked to the powerline frequency. Output from the unit modulates the r-f oscillator. A second output reaches the motor by way of a phase shifter and amplifier.

frequency power in the received signal.

The associated amplifier is well shielded to avoid blocking by any heavy radar interference picked up in the early stages. The synchronous detector circuit to be described makes unnecessary the use of tuned amplifiers. The overall gain can be varied from 40 decibels to 110 decibels in order to accommodate various antennas. Coarse adjustments in gain, covering a 50-decibel range in nine steps, are made at the receiving sites, while fine adjustments over a 20-decibel range are made remotely at the recording room. The gain of the amplifier is made stable by the use of inverse feedback, which also ensures a linear response. By careful design and shielding, a low noise level in the amplifier is achieved, allowing a high signal-to-noise ratio even for many low-gain antennas. Ratios of 100-to-1 in field strength, therefore, can be measured easily, and at maximum gain a receiver sensitivity of about 0.003 microvolt across 500 ohms is realized.

The output from the field amplifier is carried into the recording room by a 500-ohm line which is balanced to ground. The next stage is a cathode follower which presents the required low impedance to the attenuator.

A monitor device consisting of either a probe in the feed line, or a fixed antenna, picks up a portion of the transmitted signal. This fraction is then detected by a bolometer,

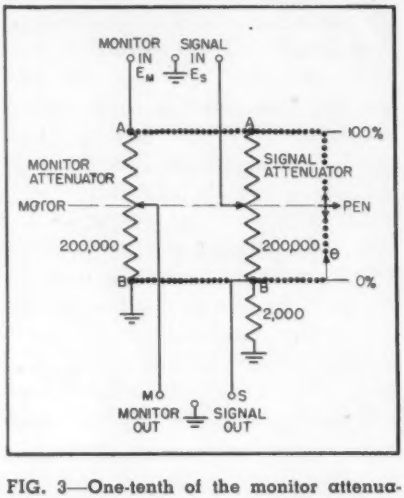


FIG. 3—One-tenth of the monitor attenuator output is compared with ten times the signal attenuator output and the resultant difference voltage drives the pen motor until the two quantities are equalized

giving an audio-frequency voltage proportional to the transmitted power. Any fluctuation in the transmitter output will affect both the signal and monitor voltages to the same extent, leaving the ratio of the two unchanged. As will be seen later, the pen position at balance is dependent on this ratio; therefore fluctuations in output do not alter the recorded pattern.

The Attenuator System

The attenuators consist of two linear potentiometers with moving contacts ganged on the same shaft that drives the recording pen. The monitor and signal voltages are applied to these attenuators in the manner shown in Fig. 3. The two outputs from the attenuators are then added out of phase, and the resultant difference voltage is amplified and applied to one field of the motor, causing it to rotate. This moves the recording pen, and at the same time, moves the contacts in such a direction that the difference voltage is reduced to zero, at which point the motor ceases to rotate. This is the balance position. The proper direction of rotation is obtained by means of the 360 degree phase adjuster in the 90-cycle supply.

It can be shown that the pen traces out a field strength pattern which is not affected by power fluctuations in the transmitter. Let θ represent the pen position expressed as a fraction of the maximum pen displacement. It will also represent the position of the two potentiometers expressed as a fraction of their maximum displacement. Then for a monitor voltage of E_m and a signal voltage E_s at the attenuator inputs (Fig. 3)

$$\text{Output of signal attenuator} = \frac{2{,}000}{\theta \times 200{,}000 + 2{,}000} E_s$$

$$\text{Output of monitor attenuator} = E_m\theta$$

The circuits that follow compare one-tenth of the output of the monitor with ten times the output of the signal attenuator. When these quantities are equal

$$\frac{E_m\theta}{10} = 10 \times \frac{2{,}000E_s}{\theta \times 200{,}000 + 2{,}000}$$

$$\theta(\theta + 0.01) = E_s/E_m$$

$$\theta \simeq (E_s/E_m)^{1/2}$$

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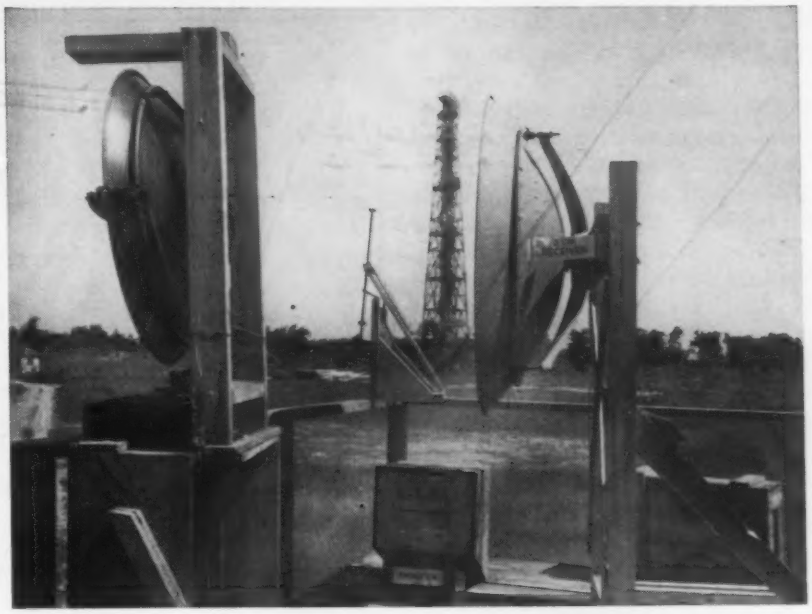

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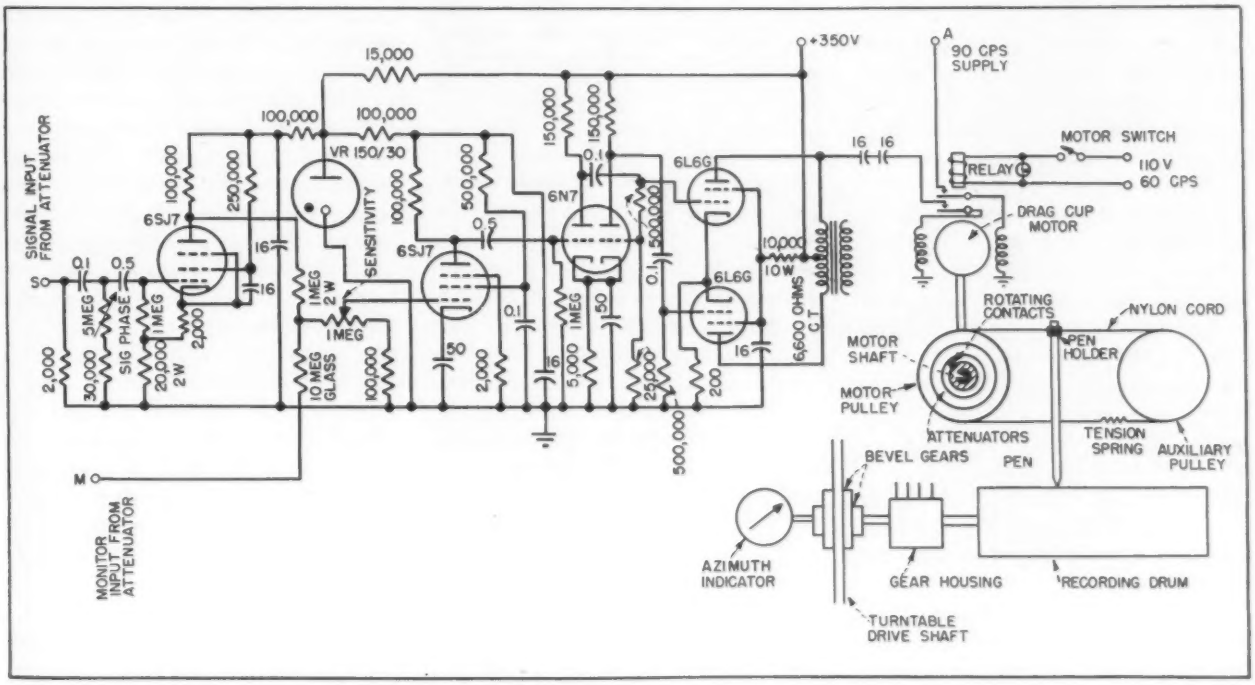

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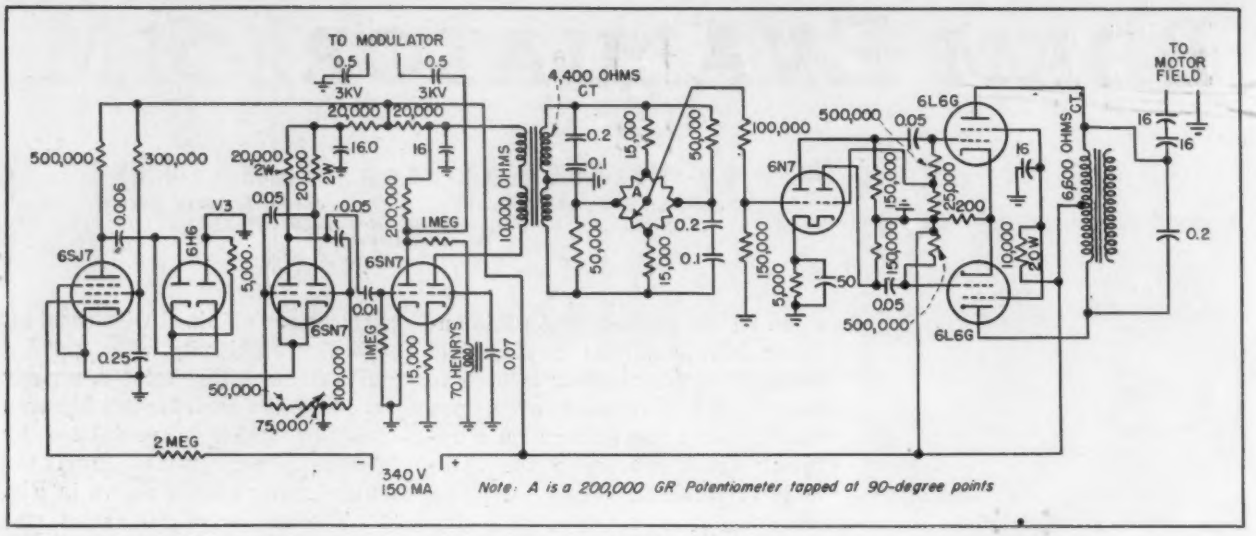

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frequency power in the received signal.

The associated amplifier is well shielded to avoid blocking by any heavy radar interference picked up in the early stages. The synchronous detector circuit to be described makes unnecessary the use of tuned amplifiers. The overall gain can be varied from 40 decibels to 110 decibels in order to accommodate various antennas. Coarse adjustments in gain, covering a 50-decibel range in nine steps, are made at the receiving sites, while fine adjustments over a 20-decibel range are made remotely at the recording room. The gain of the amplifier is made stable by the use of inverse feedback, which also ensures a linear response. By careful design and shielding, a low noise level in the amplifier is achieved, allowing a high signal-to-noise ratio even for many low-gain antennas. Ratios of 100-to-1 in field strength, therefore, can be measured easily, and at maximum gain a receiver sensitivity of about 0.003 microvolt across 500 ohms is realized.

The output from the field amplifier is carried into the recording room by a 500-ohm line which is balanced to ground. The next stage is a cathode follower which presents the required low impedance to the attenuator.

A monitor device consisting of either a probe in the feed line, or a fixed antenna, picks up a portion of the transmitted signal. This fraction is then detected by a bolometer,

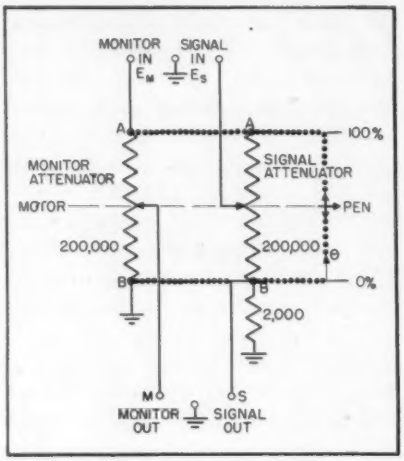

FIG. 3—One-tenth of the monitor attenuator output is compared with ten times the signal attenuator output and the resultant difference voltage drives the pen motor until the two quantities are equalized

giving an audio-frequency voltage proportional to the transmitted power. Any fluctuation in the transmitter output will affect both the signal and monitor voltages to the same extent, leaving the ratio of the two unchanged. As will be seen later, the pen position at balance is dependent on this ratio; therefore fluctuations in output do not alter the recorded pattern.

The Attenuator System

The attenuators consist of two linear potentiometers with moving contacts ganged on the same shaft that drives the recording pen. The monitor and signal voltages are applied to these attenuators in the manner shown in Fig. 3. The two outputs from the attenuators are then added out of phase, and the resultant difference voltage is amplified and applied to one field of the motor, causing it to rotate. This moves the recording pen, and at the same time, moves the contacts in such a direction that the difference voltage is reduced to zero, at which point the motor ceases to rotate. This is the balance position. The proper direction of rotation is obtained by means of the 360 degree phase adjuster in the 90-cycle supply.

It can be shown that the pen traces out a field strength pattern which is not affected by power fluctuations in the transmitter. Let θ represent the pen position expressed as a fraction of the maximum pen displacement. It will also represent the position of the two potentiometers expressed as a fraction of their maximum displacement. Then for a monitor voltage of E_m and a signal voltage E_s at the attenuator inputs (Fig. 3)

$$\text{Output of signal attenuator} = \frac{2{,}000}{\theta \times 200{,}000 + 2{,}000} E_s$$

$$\text{Output of monitor attenuator} = E_m\theta$$

The circuits that follow compare one-tenth of the output of the monitor with ten times the output of the signal attenuator. When these quantities are equal

$$\frac{E_m\theta}{10} = 10 \times \frac{2{,}000E_s}{\theta \times 200{,}000 + 2{,}000}$$

$$\theta(\theta + 0.01) = E_s/E_m$$

$$\theta \simeq (E_s/E_m)^{1/2}$$

When the pen position is ad-

Experimental Audio Output TETRODE

Low harmonic distortion is obtained from an output tetrode in which the first grid is made positive, acting as a space-charge grid, and the second grid is used as the control electrode. Tube is little affected by changes in load impedance, and is comparable to a pentode in power sensitivity

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Some years ago a space-charge grid power tube was experimentally developed with the intention of producing a tube having low distortion and high power sensitivity. Although the tube that was developed does not have the high power output available from the 6V6 beam power tube, no commercially available tetrode or pentode power tube has as low an order of distortion as does this experimental space-charge grid tube, therefore its characteristics will be described so engineers can judge whether such a tube would be desirable in current uses.

Before describing the experimental tube, it is desirable to present briefly the trends in audio output tubes by way of indicating the problems encountered with them. In the early days of radio it was unimportant to have a power tube of exceptionally high fidelity because neither audio transformers, loudspeakers, nor broadcast transmitters were of high fidelity. However, high power sensitivity was desirable because of the difficulty of building high-gain audio amplifiers which necessarily followed the triode detectors at that time widely used.

Pentodes provided the required high power sensitivity. As the quality of other circuit components improved, the high harmonic distortion of these tubes became a drawback. Second harmonics could be cancelled by push-pull circuits, but third and higher order odd harmonics remained.

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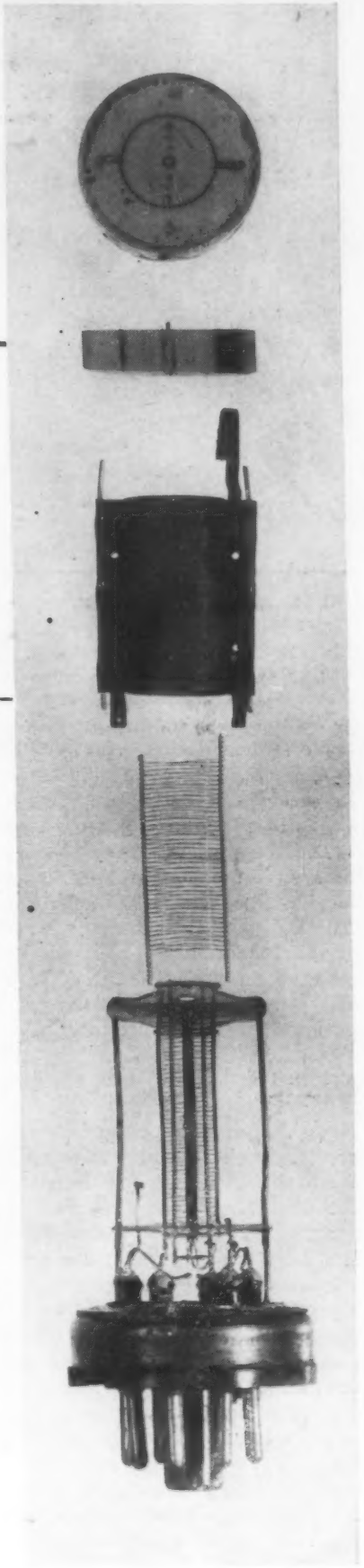

Experimental tube, cut for examination

a pulley which moves the recording pen in a straight line parallel to the axis of the cylindrical drum. Great care is taken to avoid mechanical backlash between the motor and the attenuator.

One field of the recording motor is fed by a constant voltage from the 90-cycle supply; the other by a control voltage derived by adding the attenuated monitor and signal voltages out of phase. With this arrangement, the motor responds only to frequencies within ± 2 cycles per second of the modulation frequency. Even for interfering signals within this bandwidth, the motor simply oscillates about the true value, producing a slight broadening of the pen trace. This behavior has proven to be of immense value, allowing reliable operation at times when an oscilloscope on the signal lines showed a confused mass of heavy radar interference. It is, of course, necessary to be able to obtain the correct phasing of the monitor, signal, and supply voltages, but once this has been accomplished, readjustments need only be made following replacement or interchange of a major system component. Small phase errors cause sluggish movement of the recording motor, which is easily spotted and corrected.

Plotting Antenna Pattern

In order to take a pattern, a sheet of graph paper with rectangular coordinates (which is most suitable for high-gain antennas) is placed on the drum so that the abscissa is along the circumference and the ordinate is parallel to the axis of the cylinder. The abscissa is, therefore, proportional to the angular rotation of the antenna. The drum turns through an arc length of ten inches (to fit the scale of the graph paper) and by shifting gears on the gear housing, it is possible to take patterns for 20, 40, 200, or 400 degrees on this length of arc. In this manner, the operator is able to select the azimuthal expansion most suitable to the width of the radiated beam.

Before taking the pattern, the antenna under test is turned to the position of maximum gain, which is indicated by a vacuum-tube voltmeter on the signal line at the input

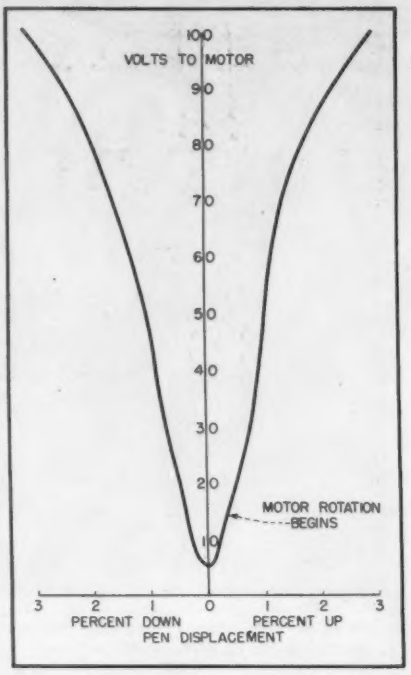

FIG. 5—The voltage at the motor terminals is shown as a function of pen position in percent of full-scale displacement from balance

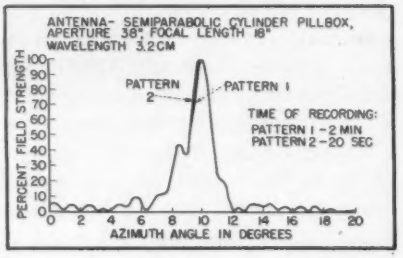

FIG. 6—The effect of increasing recording speed is shown in pattern 2, wherein a 5 percent error has been introduced by changing the field strength by 60 percent of full scale in one second

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Accuracy of the System

It has been stated that the bolometer and amplifier make a negligible contribution to the error in the pattern. Linear wire-wound potentiometers from stock give an attenuator unit in which the systematic error never exceeds 0.5 percent. The remaining factor in the accuracy of the recorder is the response of the recording motor to changes in field strength. The motor starts rotating at 15 volts, which corresponds to approximately 0.3 percent pen displacement, as shown in Fig. 5.

If a higher recording sensitivity is used in an attempt to reduce this figure, the motor will tend to hunt at the recording speed most commonly used. This effect will necessitate a lower speed to avoid sudden changes in field strength. If a lower sensitivity is used, the percent displacement over which the recording motor will not respond is increased, thus giving less accuracy in the pattern. The sensitivity used is a compromise between these factors, and allows accuracy within 1 percent, along with a high recording speed, without hunting.

It would also be possible to feed back in phase opposition the voltage from a second motor driven by the first and acting as a generator. This would have the effect of reducing the effective inertia of the mechanical system, and increasing the permissible pen speed. The drag-cup motor has such a good ratio of torque-to-inertia, however, that the feedback was considered unnecessary.

It has been found that for accurate patterns, the rotation speed of the antenna under test should be such that the field strength does not change by more than 40 percent of full scale per second. In general, adequate recording speed has always been found available. A 20-degree pattern with a 2-degree beamwidth at 6 decibels down can be taken easily in about one minute, and a 400-degree pattern of the same antenna in five minutes. Two 20-degree patterns recorded at different speeds (one in 2 minutes, the other in 20 seconds) are shown in Fig. 6. The two patterns are practically identical, except for a 5 percent error where the field strength changed 60 percent of full scale in one second at the faster recording speed.

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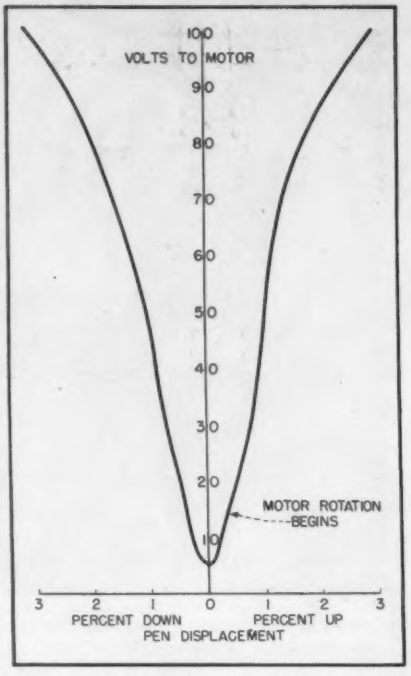

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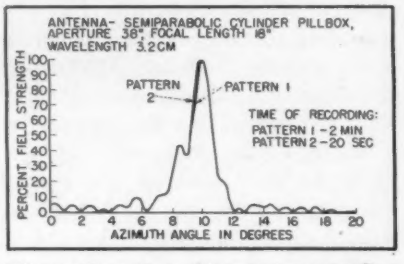
ANTENNA- SEMIPARABOLIC CYLINDER PILLBOX,
APERTURE 36" FOCAL LENGTH 18"
WAVELENGTH 3.2CM
PERCENT FIELD STRENGTH
PATTERN 2
PATTERN 1
TIME OF RECORDING:
PATTERN 1 - 2 MIN
PATTERN 2 - 20 SEC
0 2 4 6 8 10 12 14 16 18 20
AZIMUTH ANGLE IN DEGREES

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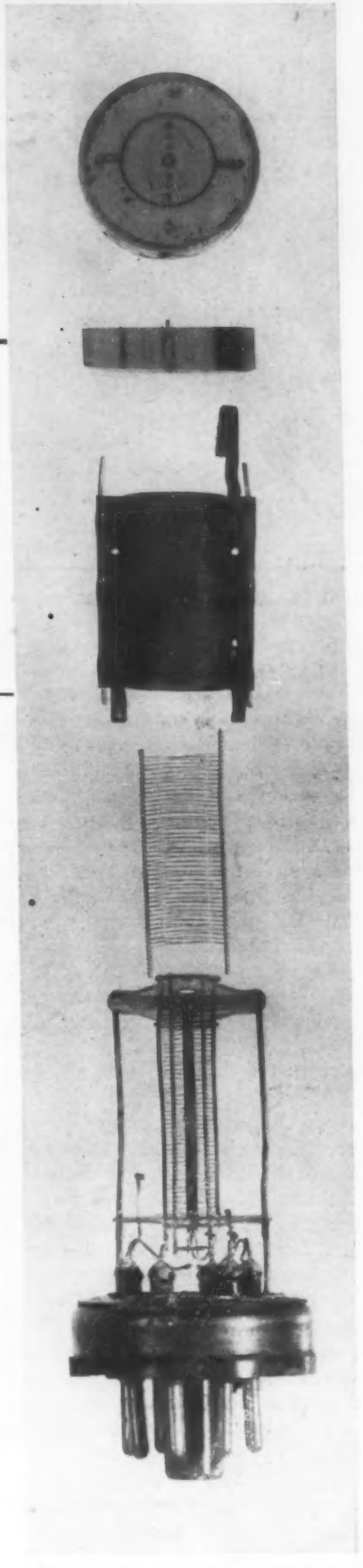

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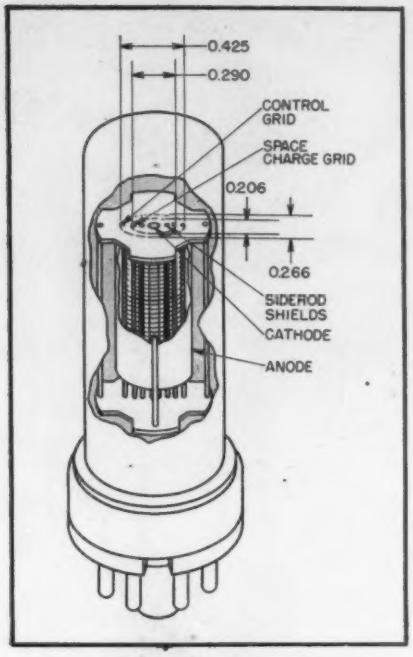

FIG. 1—Experimental space-charge grid power output tetrode dimensions

fied by selective negative feedback. Nevertheless, the triode remains the type tube preferred in high-fidelity audio systems.

These trends are well illustrated by several familiar tubes. The 45 exemplifies the triode power output tube, it being the first triode to deliver more than one watt of undistorted output (total harmonic content not greater than ten percent of the fundamental) with a rated plate potential of 250 volts. With this plate voltage, a negative grid bias of 50 volts, and a load of 3,900 ohms, the 45 gives 1.6 watts of undistorted output for an input signal of 35 volts rms. This load resistance gives the greatest power output, greater load resistance decreases the available output and decreases the distortion. The first pentode power output tube was the 47, rated at 2.7 watts output with 250 volts on plate and screen, a negative grid bias of 16.5 volts, and only 11.5 volts rms signal input. The output falls sharply, however, with lowered load resistance, and the odd harmonic distortion is high at any load. The 53 twin triode operating push-pull with 300 volts on the plates gives 10 watts output, but must be driven from a low-impedance source if the distortion is to be kept low. The familiar 6L6 is the first beam power tube. With 250 volts on plate and screen, a negative grid bias of 14 volts, a peak signal input of 14 volts, and a 2,500 ohm load, the 6L6 delivers 6.5 undistorted watts.

In all of these tubes, the power output and, more especially, the harmonic distortion, are greatly affected by load impedance. Inasmuch as these tubes are used to drive loudspeakers, whose impedances vary widely with frequency, frequency distortion is also present. In the case of triodes, the second-harmonic distortion increases with decreasing load impedance. Pentode loads are chosen to give a compromise between high output and low third harmonics; load variations affect both factors. High outputs could be obtained from triodes operating in push-pull class-B, but only with low-impedance high-level drivers. Low distortion could be obtained from pentodes or beam-power tubes with degenerative feedback to reduce effects of changing load impedance, but only at a sacrifice of power sensitivity. In other words, the basic cause of distortion in these latter tubes is their high internal plate resistance.

Tube for High Fidelity

Figure 1 shows the construction and typical dimensions of a tube designed for space-charge grid operation. Tubes not designed for this type of operation are unsuited to it because the space-charge grid draws excessive current. In operation the first grid is made positive with respect to the cathode; its effect is to counteract the negative space charge and to produce a cloud of electrons at the plane of the first grid. This cloud acts as the virtual cathode. The operation of such a tube is similar to that of a triode with a large effective cathode area, behaving as if it were temperature limited. The second grid is then the control electrode. Screens and suppressors can be added, but as their effect will be, among others, to increase the dynamic plate resistance, which is undesirable in power output tubes driving loudspeakers, they were not used in the experimental tube under discussion.

To reduce the space-charge grid current, two siderods were introduced between the cathode and the supports of the space-charged grid. These siderods could be electrically connected to either the cathode or the control grid. By thus restricting the path of electrons to the vicinity of the lateral wires of the space-charge grid, its current was reduced about two-thirds. The spacing between space-charge grid and cathode was also adjusted to obtain an optimum between low space-charged grid current and high plate transconductance.

Figure 2A shows the characteristics of a space-charge grid tube operating at 6.3 volts and 0.7 ampere on the heater, the space-charge grid supplied from the 250-volt supply through a 10,000-ohm resistor —giving an average space-charge

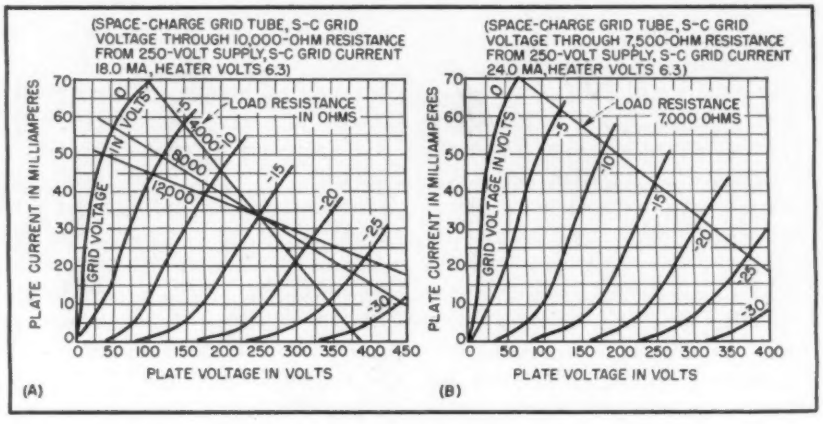

FIG. 2—Plate characteristics of space-charge grid tetrodes are similar to those of a triode. Comparing (A) with (B) shows the effect of space-charge grid bias on the plate characteristics

grid potential of 70 volts, and an average current of 18 ma, the plate supplied from the 250-volt supply through a 7,500-ohm load, and the control-grid bias at −15 volts — giving a plate current of 33 ma. Power output under these conditions is 2.4 watts with less than 1.5 percent total distortion. Varying the load from 5,000 to 12,000 ohms does not increase the total distortion to over 5 percent.

Figure 2B shows the tube's characteristics with a space-charge grid resistor of 7,500 ohms. Plate current increases to 41 ma, space-charge grid current to 24 ma, but the output power increases to only 2.6 watts, giving a much lower efficiency.

Table I—Comparison of Space-Charge Grid Tetrode with Beam Tetrode

	Experimental Space-Charge Grid Tetrode	Typical (6V6) Beam Tetrode
Heater		
volts	6.3	6.3
amps	0.7	0.45
watts	4.6	2.8
Auxiliary Grid	(Space-Charge Grid)	(Suppressor Grid)
volts	250	250
milliamps	18	4.5
watts	4.5	1.3
Control Grid		
bias volts	−15	−12.5
volts signal swing	10.6*	12.5
Plate		
volts	250	250
milliamps	33	45
watts	8.3	11.3
percent total distortion	1.5	8
Power output watts	2.4	4.5
Overall % efficiency	13.8	29.2

Note: Volts listed under auxiliary grid are supply volts, which include grid voltage and voltage lost in dropping resistor. The efficiency is thus the efficiency of the circuits in toto, not of the tubes alone.
* Peak signal voltage equals operating bias, being increased until a microammeter in grid circuit indicates reversal of current.

Space-Charge Grid Effect

Second-harmonic distortion was reduced by the same method that space-charge grid current was reduced. The high impedance of the space-charge grid to cathode region greatly reduced the effect of plate voltage on primary cathode current with the result that plate current at high negative grid voltage was lower than in a comparable triode. The effect is a greatly reduced even-harmonic distortion. Further harmonic reduction was obtained by tying the siderods to the control grid, thus increasing the plate transconductance at high negative control-grid voltages but having negligible effect at grid voltages near zero.

Operating the space-charge grid through a dropping resistor without a bypass has three important effects: First, such operation slightly increases the output for a given average cathode current. Second, it stabilizes the output over a wide range of external load impedances. Third, it reduces odd-harmonic distortion.

Operating Conditions

To visualize the foregoing effects, compare Fig. 3A with Fig. 2. Figure 3A shows the tube's characteristics with a fixed potential of 50 volts on the space-charge grid (corresponding to well bypassed dropping resistor operation). The variation in the increment of plate current along a load line (not shown) with respect to grid voltage indicates odd-harmonic distortion.

The space-charge grid can be compared in some respects to the screen grid of a beam-power tube. The space-charge grid current is relatively high, but even so the power dissipated in it is only 1.5 watts with a 10,000-ohm dropping resistor. Although the maximum output of approximately 2.5 watts is less than that from a 6V6 beam tetrode, the power sensitivity of the space-charge grid tube does not vary with input signal level, being as high at low signal levels as at high. The effect is, in a phonograph amplifier for example, greater brilliance with less apparent needle scratch, due to the reduced higher order harmonics of the space-charge grid tube over a beam-power one. Figure 3B compares the output power and harmonic distortion of a typical beam tetrode with the space-charge grid tube. The low distortion of the latter recommend it for use in high-fidelity audio output amplifiers.

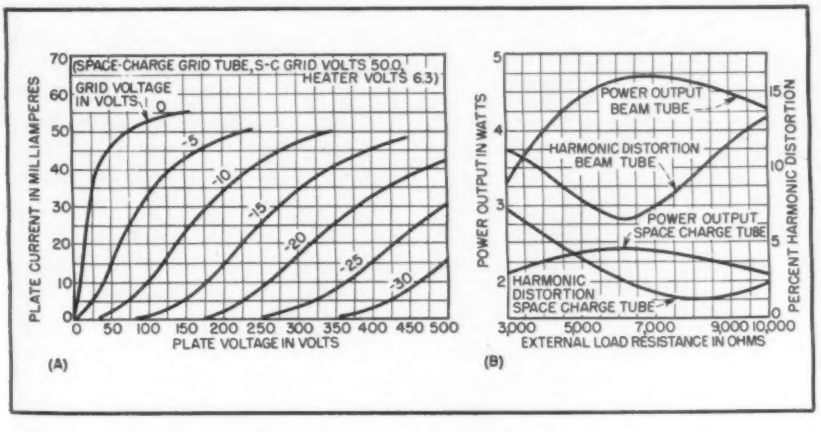

FIG. 3—(A) Without space-charge grid degeneration, characteristics are nonlinear. (B) Comparison of space-charge grid tetrode with conventional beam tetrode shows lower distortion of the former

Frequency Response of

Magnetic properties, physical dimensions and velocity of a magnetic recording medium are discussed and evaluated. Features and performance of electroplated wire and powder-coated tape are described

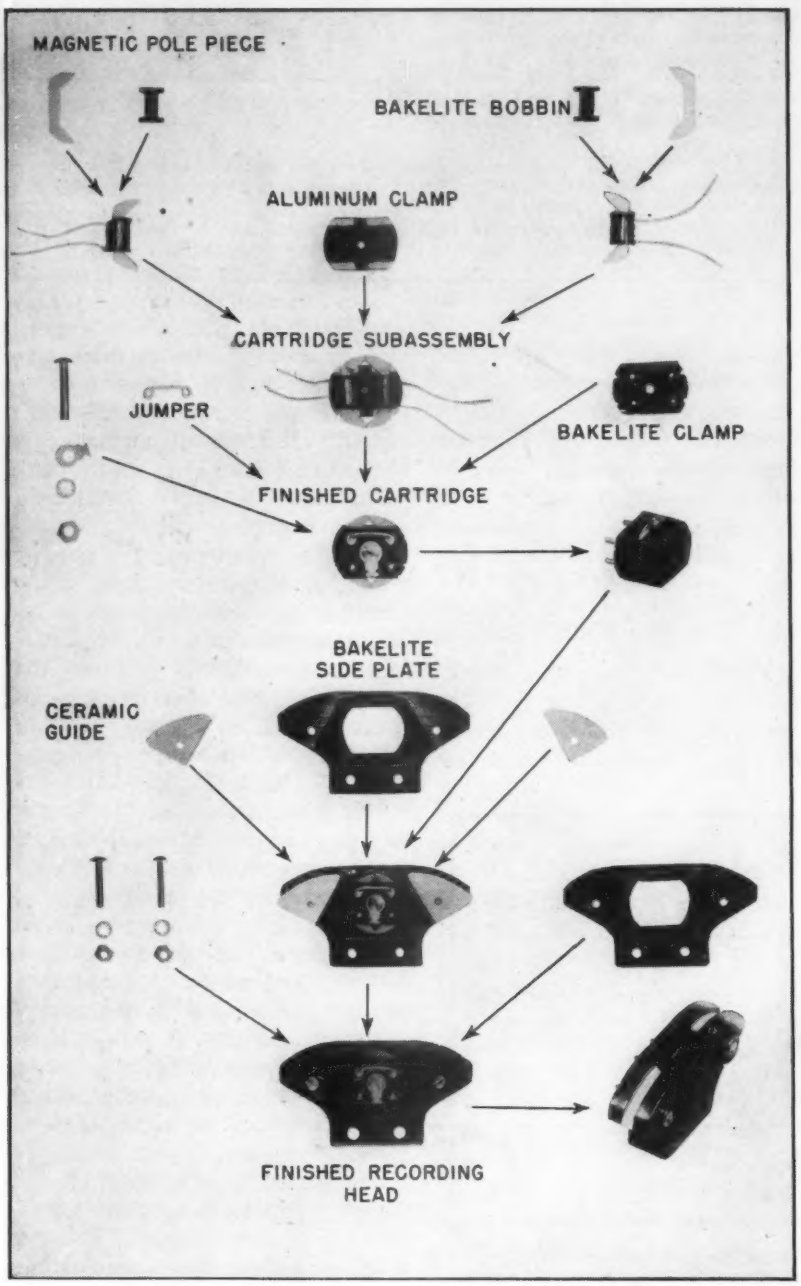

FIG. 1—Assembly details of a ring head designed for recording on wire or narrow tape. It consists of an essentially closed magnetic circuit that engages the recording medium on one side only

THE MOST REVEALING information about the mechanism of the phenomena which control any recording method may be obtained from an investigation of the reproducing process. Previous investigators have analyzed the response by empirical curve fitting[1] or theoretical considerations.[2,3]

Assume that a sinusoidal signal has been linearly recorded with a ring head (Fig. 1) on a uniformly moving medium and that the recording was done with constant current through the recording head, independent of frequency; that is, essentially, with constant peak induction in the recording medium.

The resulting record may be looked upon as a longitudinal arrangement of bar magnets of an individual length equal to one-half of the recorded wave, sinusoidally magnetized and with like poles joining. This is schematically shown in Fig. 2.

The flux lines representing the internal magnetization B_i of these magnets must all close through the space surrounding them, thereby passing through their surface, creating there a certain surface flux density B_s. The latter determines the induction B_h in the magnetic circuit of the ring head contacting the recording medium. The reproducing voltage, e, generated in the head winding is proportional to the rate of change of the flux passing through the head.

The trend of this voltage, as a function of frequency, is derived, under simplifying assumptions, in Fig. 2 (at bottom). The reproducing voltage for very long wavelengths has theoretically a tendency to rise at a slope of 18 db per octave and this slope, with decreasing wave-

Magnetic Recording

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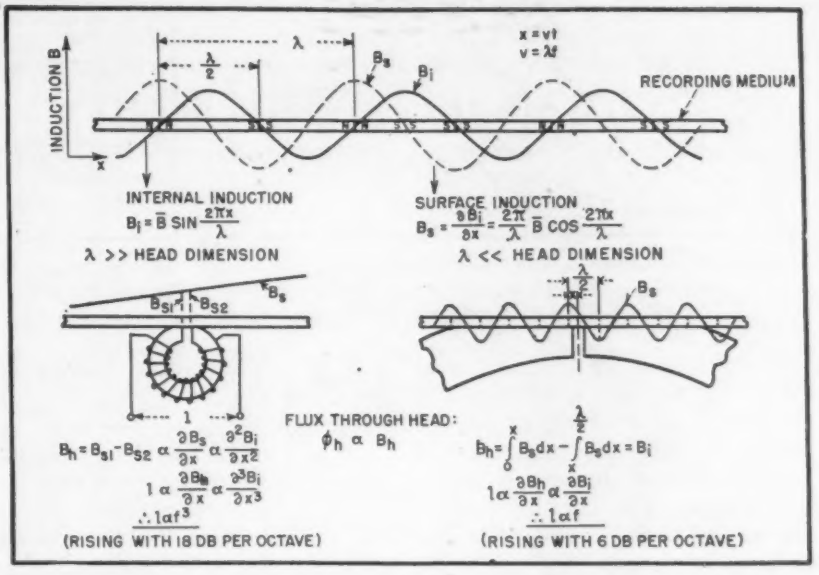
INDUCTION B
λ
λ/2
B_s
B_i
x = vt
v = λf
RECORDING MEDIUM
INTERNAL INDUCTION
$B_i = \bar{B} \sin \frac{2\pi x}{\lambda}$
SURFACE INDUCTION
$B_s = \frac{\partial B_i}{\partial x} = \frac{2\pi}{\lambda} \bar{B} \cos \frac{2\pi x}{\lambda}$
λ >> HEAD DIMENSION
λ << HEAD DIMENSION
B_{S1}
B_{S2}
$B_h = B_{S1} - B_{S2} \propto \frac{\partial B_s}{\partial x} \propto \frac{\partial^2 B_i}{\partial x^2}$
$1 \propto \frac{\partial B_h}{\partial x} \propto \frac{\partial^3 B_i}{\partial x^3}$
$\therefore 1 \propto f^3$
(RISING WITH 18 DB PER OCTAVE)
FLUX THROUGH HEAD:
$\phi_h \propto B_h$
$B_h = \int_0^x B_s dx - \int_x^{\frac{\lambda}{2}} B_s dx = B_i$
$1 \propto \frac{\partial B_h}{\partial x} \propto \frac{\partial B_i}{\partial x}$
$\therefore 1 \propto f$
(RISING WITH 6 DB PER OCTAVE)

FIG. 2—Interaction between the recording magnetic medium and the reproducing ring head with a sinusoidal signal

length, gradually changes into 6 db per octave. A very long wave is one whose length is great compared with the longitudinal extension of the zone of magnetic interlinkage between recording medium and heads; that is, roughly, the length of the contact area between the two or about the longitudinal head dimensions (see Fig. 2). This wavelength range almost always lies below the range of practical interest.

The observed shape of the frequency response curve follows this simplified prediction only to a limited extent. There is good agreement in the very low and part of the medium frequency range, but with increasing frequency the slope of the observed curve falls more and more short of the predicted 6 db-per-octave line. The curve even reverses its trend eventually and starts to fall gradually as the frequency increases further. Consequently, there must be certain effects, responsible for this deviation.

Demagnetization

The most important of these effects is the self-demagnetization of the described elementary bar magnets. It is well known that the magnetomotive force available across the ends of an open bar magnet, or the useful induction which it can generate, decreases due to its own magnetization. The figure which relates this decrease to the magnetization is called the demagnetizing factor; it depends almost entirely on the physical shape of the magnet and becomes smaller as its ratio of length to diameter increases.

Figure 3 shows the familiar graphic method of finding the decreased induction of a magnetic structure when its intrinsic hysteresis loop and its demagnetizing factor N are known. A straight line, called the shearing line, is drawn through the origin at an angle whose tangent is proportional to the demagnetizing factor. The intersection P of this line with the hysteresis loop then gives the induction B'_r effective in the magnet, as compared with the highest induction B_r which would exist if the magnet were either closed or infinitely long.

The reduced induction values of all other points of the intrinsic hysteresis loop may be found in a similar manner. The locus of the new points describes the behavior of the open magnetic circuit and is called the sheared hysteresis loop. It is of importance in the investigation of all magnetic circuits containing portions of increased reluctance, including powder-coated recording media.

The demagnetizing effect is one reason for the response of a magnetic frequency record to decrease below the predicted 6 db-per-octave line. As the frequency increases, the length of the elementary bar magnets decreases which, in turn, causes an increase of the demagnetization. The demagnetizing factors in the case of magnetic recording are not exactly predictable because the adjacent elementary magnets interact with each other and are shunted during the playback process by the reproducing head. An approach to the solution of this problem has been made by Camras.[3]

It was pointed out that the slope of the shearing line depended only upon the demagnetizing factor; that is, in this case, upon the recorded wavelength. The ordinate B'_r at the intersection of the shearing line with the demagnetization curve is approximately proportional to the reproduced voltage and will decrease more slowly with increasing demagnetizing factor, the flatter the demagnetizing curve of the recording medium. The average flatness may be roughly defined by the ratio of coercive force to remanence. Accordingly, an improvement in the high-frequency response can be observed, with an increasing ratio of coercive force to remanence, irrespective of their absolute magnitudes.

From several materials with the same ratio of coercive force to remanence, the one with the highest

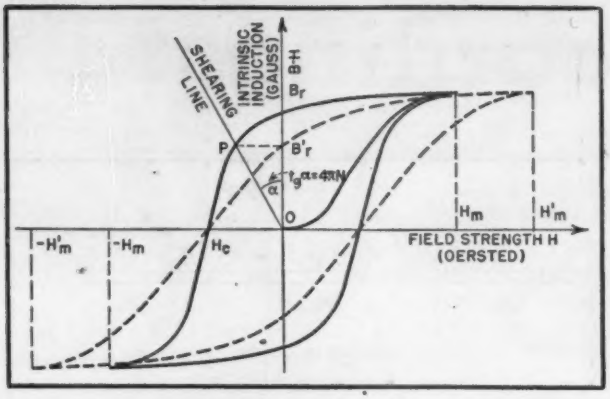

FIG. 3—Magnetization of a ferromagnetic material. The solid curves apply to a closed magnetic circuit and the dashed curves to an open magnetic circuit

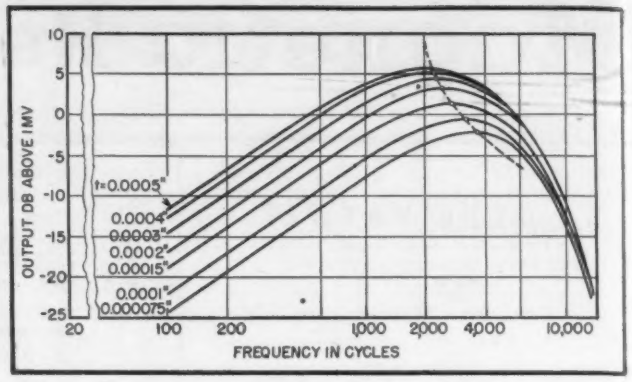

FIG. 4—Frequency response of electroplated brass tape operating at a velocity of two feet per second. Thickness is represented by *t*

absolute values (within practical limits) of the two quantities will still be the more desirable. The reason is that this material will yield the highest absolute reproducing level, because of its high remanence, and that it will offer the greatest resistance to accidental demagnetization by external fields because of its high coercive force.

Penetration

Based on the concept of the demagnetizing effect, the response of a thin recording medium might be expected to be superior to the response of a thicker one. However, experiment does not always verify this expectation since the response curves of all media within usual dimensions (thicknesses of a few thousandths of an inch) are found to be substantially alike, other conditions being equal. In an attempt to clarify this apparent contradiction, certain measurements were made whose results are represented in Fig. 4. Here are shown the response curves of several recording media, which differ only in their thickness. The absolute values of the thicknesses are very small.

Disregarding the absolute reproducing level, the frequency response of these very thin media actually does improve with decreasing thickness. Since all the curves have substantially the same shape, the position of the maxima of these curves forms a simple criterion for their frequency characteristic. The dotted line connecting these maxima shows that the improvement of high-frequency response is more rapid in the range of the thinnest media than in the range of the relatively thicker ones, tending toward no change at all for still thicker media.

This peculiar behavior can be explained by the assumption that the physical depth of magnetization of the recording media is dependent upon the recorded wavelength. The phenomenon may be termed penetration effect.

All wavelengths penetrate magnetically into the recording medium only to a limited depth; the longer ones penetrate more than the shorter ones and the absolute magnitude of this penetration is normally in the order of under one thousandth of an inch. Accordingly, the frequency response of the relatively thick commercial recording media is hardly affected by limited thickness variations since most of their cross section is inactive, that is, not penetrated by useful magnetic flux. When the thickness of the medium is substantially reduced to the order of the depth of penetration, the low frequency range will be impaired first, which means that the upper frequency range will be relatively favored.

In extremely thin carriers where complete penetration can be assumed over a wide frequency range, there is no selective influence of the penetration effect any longer. The frequency response is then controlled by the demagnetizing effect alone. Because of the increasing dimensional ratio of the elementary magnets, a thickness reduction by a certain ratio should have the same effect upon the response as an increase of the medium velocity by the reciprocal ratio. The absolute reproducing level, however, will drop by the same ratio because of the decreased cross section. This statement seems to be verified by the trend of the dashed line in Fig. 4, which approaches a slope of minus 6 db per octave for progressively decreasing thicknesses.

The penetration effect is another important factor which causes deterioration of the high-frequency response of commercial recording media since it results, with decreasing wavelength, in a gradual decrease of the effective cross section of the recording medium. (Shunting of the magnetized layer due to the presence of the inactive material does not seem to be serious.)

The penetration effect must not be confused with the magnetic skin effect since it has been found that the penetration is a function of the wavelength only, and not of the frequency. Its mechanism may be explained by the geometry of the flux lines entering the medium in the recording process. The course of these flux lines, which determines the depth of penetration, appears to depend primarily, for a given wavelength, upon the gap width and the permeability of the recording medium—greater gap width and lower permeability favoring deeper penetration.

One particular question that arises is that if the penetration decreases with rising frequency how is it possible to erase and to bias[4,5] with very high frequencies? The answer is probably that in the erasing process the recording medium has to be carried into saturation; in this range, however, its permeability approaches unity so that sufficiently deep penetration

becomes possible for evident reasons of flux distribution. A somewhat similar condition prevails in the case of high-frequency bias. In this situation the recording medium works essentially within the toe of its normal magnetization curve where the permeability is also very low.

Gap Effect

Another effect which contributes to the loss of the reproduced level as the frequency increases is the almost purely geometric influence of the finite gap width of the reproducing head. The effect exists basically in any method of scanning a recorded signal. Figure 5 shows a representation of the function relating this loss to the ratio of gap width to recorded wavelength. It can be seen that no reproduction takes place when this ratio equals unity (or any integer).

The loss as shown describes the conditions for the reproducing process only.

It should be emphasized that the effective gap width of the reproducing head is not identical with the physical dimension of the gap. Magnetic leakage causes a certain spread of the zone of mutual influence between recording medium and gap, resulting in an effective gap width which may be determined to be up to about 40 percent larger than the physical gap width.

Figure 6 shows, in a qualitative manner, the three discussed effects which control the shape of the frequency-response curve of magnetic recording as obtained with ring heads. The solid curve gives the general appearance of an observed response. The vertical distances between this curve, the two dotted curves, and the theoretical 6 db-per-octave line indicate the respective loss contributions of demagnetization, penetration, and gap effect.

Velocity

Figure 6 also indicates a convenient graphic method of converting a response curve established at a velocity v of the recording medium into the curve at some other velocity v': A 6 db-per-octave line is drawn through any point P of the given curve, plotted in the conventional double logarithmic system. On this line, point P' is found by spacing it from P at a horizontal distance which equals, as a frequency ratio, the ratio of the two velocities. The new curve (dash-dotted) is then found by shifting the original curve bodily along the 6 db-per-octave line to its intersection at P'. (The points P and P' on the two curves correspond to frequencies with equal wavelengths.)

The noise originating from a magnetic recording medium is evidently generated by random flux variations picked up by the reproducing head. These variations may have two different causes. The first one is the random fluctuation of the reluctance across the gap of any or all of the heads, brought about by either mechanical vibration or surface roughness of the recording medium. The second cause is the inherent grain structure of the recording material. Here, the magnetic discontinuities at the boundaries of the individual grains or domains will also cause minute flux variations.

Vibration and surface roughness of the medium can be minimized by appropriate design of the drive mechanism and by careful preparation of the medium.

The noise reproduced from a given recording medium will depend upon the magnetic state of the medium. A completely demagnetized medium will result in the least noise as evidenced by the low noise level obtained from an a-c erased in contrast to a d-c erased recording medium.

An important consequence arises from this recognition. A recording medium—after a-c erasing and subsequent recording—is demagnetized only in the portions where no signal is recorded. Wherever there is a signal, there will be magnetization corresponding to the instantaneous value of this signal. The signal itself, consequently, causes noise which follows the instantaneous sig-

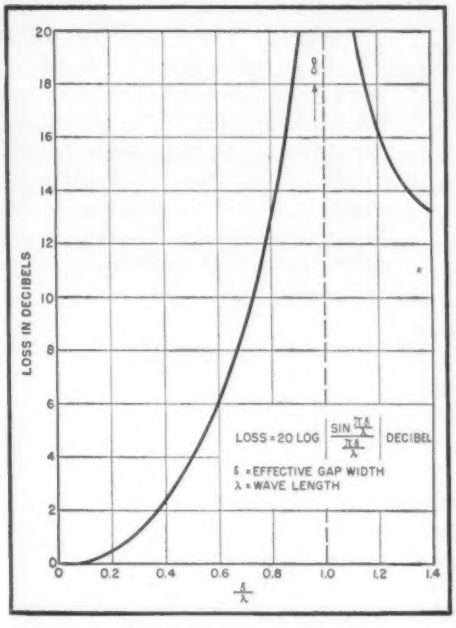

FIG. 5—Playback loss due to gap effect

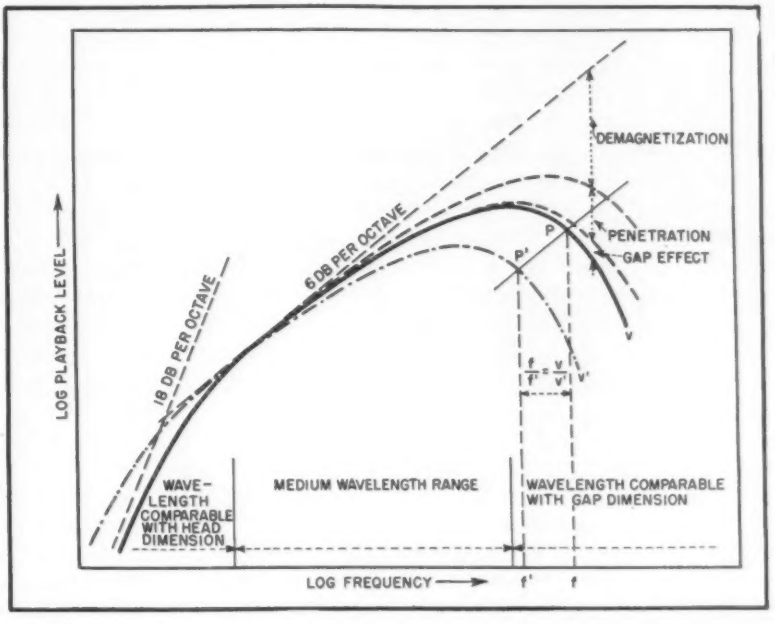

FIG. 6—Synthesis of the response curve of a magnetic recording medium

nal level in its magnitude. This type of noise, closely related to but less objectionable than the continuous noise after d-c erasing, has been termed modulation noise or noise behind the signal. Its magnitude depends on the factors discussed before and noise values up to about 15 db above the no-signal-noise have been measured at the crest of a maximum signal.

For the generation of noise it is immaterial whether the recording medium or the associated reproducing head is magnetized since the two form one magnetic circuit during the reproducing process. An accidentally magnetized reproducing head will therefore also cause noise and great care has to be taken to reduce or eliminate the remanent magnetization of the reproducing head. This can be done by proper selection of the core material, by the introduction of an additional air gap into the magnetic circuit or by purposely demagnetizing the head whenever required.

Most magnetic recording media until now have had the form of fine wires or of thin tapes. Originally, plain carbon steel was used but has been replaced by various alloy steels, particularly the ternary alloys of iron and nickel-chromium, nickel-copper or cobalt-copper. The coercivity of these materials has thus been increased from about 25 oersteds for carbon steel to about 150 to 250 for various commercial recording media and up to over 400 for some experimental media.

All these recording media are produced by rather closely controlled drawing or rolling operations combined with a suitable heat treatment to effect and maintain the desired physical and magnetic properties. These procedures are difficult and expensive, particularly since the required magnetic hardness of the materials is usually accompanied by physical hardness.

One quite successful solution to this problem has been found to be the electroplating of a ductile, nonmagnetic base material with a ferromagnetic layer.[6] The base material for plated recording media is, ordinarily, brass in the form of fine wires or tapes. However, other shapes, for instance, disks or cylinders, may be processed just as readily which is of importance for special applications.

The plated layer usually consists of a cobalt-nickel alloy, applied to a thickness of about 0.0003 inch. This dimension provides a practical compromise between frequency response, reproducing level and production cost. The material has a coercivity of over 200 oersteds and a retentivity of about 10,000 gausses. The plating is very uniform and ductile, has a mirrorlike surface and fine grain structure, as evidenced by a low noise level. No heat treatment is required since the internal stresses, necessary in any permanent magnet material, are automatically created in the plating process.

The frequency response curves shown in Fig. 4 may be considered representative of the performance of the present plated media. Plated recording wires can now be produced at a rate of about 150 feet per minute, and up to 500 feet per minute have been experimentally obtained.

Magnetic Tape

The ability of a recording medium to exhibit a good high-frequency response depended primarily on its ratio of coercive force to remanence. This ratio determines the specific magnetic reluctance of the recording material and has definite limitations in most homogeneous materials. However, it can be artificially increased by using the ferromagnetic material as a fine powder, uniformly dispersing this powder in a suitable binder, and coating the resulting mixture on an inert base material to form the recording medium.[7] The magnetic reluctance of such material, when measured in bulk, will be very greatly increased by the presence of the minute interstices separating the individual particles. The effective induction will, consequently, be reduced from the intrinsic value of the powder while the coercive force remains unchanged (sheared hysteresis loop), thus giving the desired result of a greatly decreased slope of the demagnetization curve. If both particle size and their separating distances are made small in comparison with the shortest wavelength to be recorded, such a disperse material will behave like a homogeneous material.

The ferromagnetic powders for recording media may be produced from any suitable permanent-magnet material but experience has shown that various magnetic iron oxides are most readily and economically applicable. These powders, with a particle size of about 1 micron and an intrinsic coercive force[8] between 100 and 250 oersteds, are now predominantly used for the commercial production of powder-coated recording media in the form of tapes or sheets. The remanence of the iron oxide coating is usually between 400 and 800 gausses, about one order of magnitude below that of the more common homogeneous recording media.

The coating, containing between 25 and 40 volume percent of magnetic powder, is applied with a thickness of about one-half thousandth of an inch to a base of paper or thin plastic. The resulting recording medium exhibits extremely low background noise and a frequency response far superior to any homogeneous medium now in use. For a given frequency response powder-coated media can be run with roughly about one-half of the speed required for homogeneous media.

The reproducing level from powder-coated media is inherently low because of their low effective induction; but this deficiency can be compensated for by using a correspondingly wider recording track.

This paper is based, in part, on work done for the Office of Scientific Research and Development under Contract OEMsr-254 with The Brush Development Company. A number of facts presented in this paper were first published, in essence, in OSRD Report No. 5325, of June 30, 1945.

References

(1) H. von Lubeck, *Akust. Zeitschr.*, 2, p 273-295, Nov. 1937.
(2) D. E. Wooldridge, *AIEE Trans.*, 65, p 343-352, June 1946.
(3) M. Camras, *Proc. I.R.E.*, 34, p 320-326, Aug. 1946.
(4) Toomim, Hershel & Wildfeuer, *Proc. I.R.E.*, 32, p 664-668, Nov., 1944.
(5) L. C. Holmes and D. L. Clark, ELECTRONICS, 18, p 126-136, July, 1946.
(6) P. O. Pedersen, U. S. Patent 836,339, granted, Nov. 1906.
(7) J. A. O'Neill, U. S. Patent 1,653,467, granted, Dec. 1927.
(8) G. W. O. Howe, *Wireless Eng.*, 20, p 469-472, Oct. 1943.

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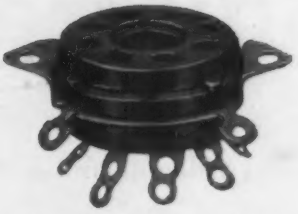

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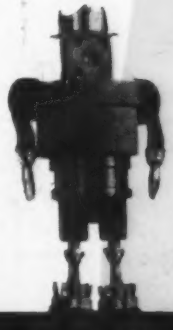

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Square-Wave Response

Nomograph correlates tilt of square wave after passage through uncompensated RC-coupled video or audio amplifier with low-frequency response of amplifier and time constant of coupling circuit

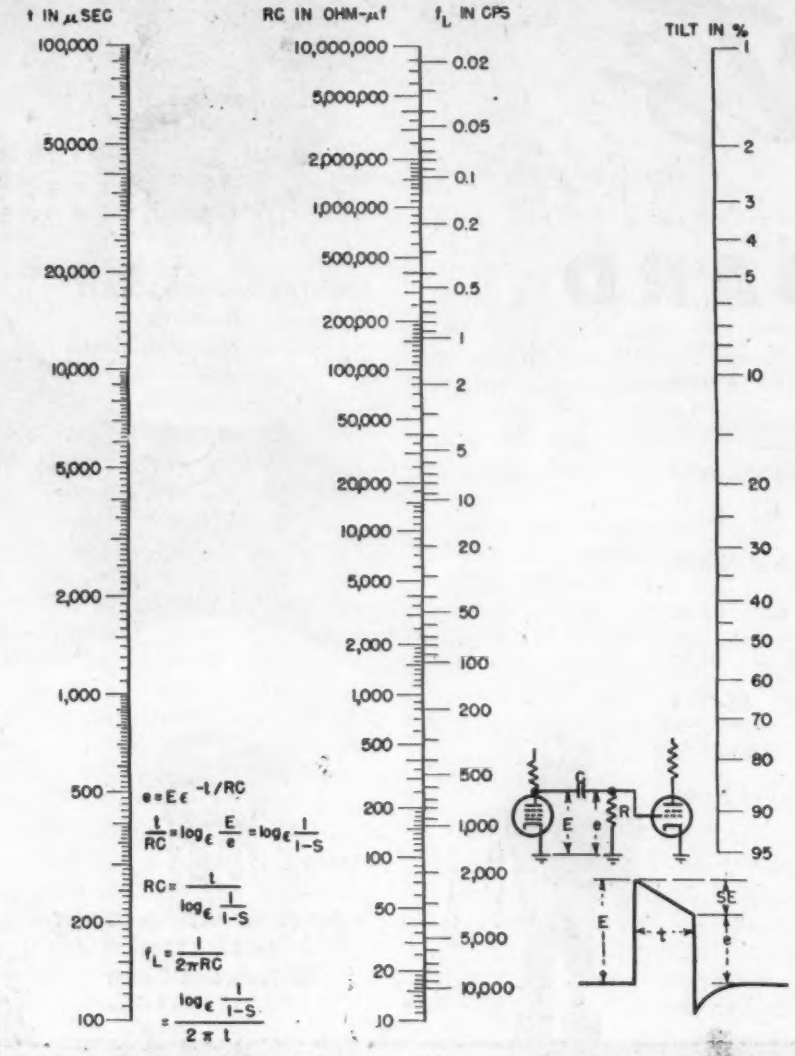
By A. J. BARACKET

Head, Television Studio Facilities Section
Research and Development Division
Allen B. DuMont Laboratories, Inc.
Passaic, New Jersey

WHEN USING rectangular or square waves for testing audio and video amplifiers, the output of the amplifier is compared with the input on an oscilloscope. The degree or percent of tilt of the top of the square wave represents the amplifier's deterioration of the lower frequencies.

In the uncompensated RC-coupled amplifier stage shown, the effect of the amplifier on low frequencies is almost completely a function of the value of the RC time constant in the grid coupling circuit. The smaller the time constant, the poorer the low-frequency response and consequently the greater the percent tilt S of a rectangular wave (referred to the peak plate voltage value E, as indicated on the waveform diagram).

The accompanying nomograph is useful in computing the RC value required to give a maximum specified tilt S (expressed as a decimal part of E) for a rectangular wave having a duration t, or conversely it may be used to determine the tilt that will be obtained from a given time constant. The chart also gives the relationship between tilt and low-frequency cutoff of an amplifier coupling circuit (the frequency f_L at which the amplitude—frequency response characteristic is down 3 db).



Example of Use

The percent tilt of an uncompensated video amplifier stage is specified as 2 percent maximum on a 60-cycle square wave. What will be the required time constant of the coupling circuit and the corresponding low cutoff frequency?

By means of a straightedge, connect the 2-percent point on the tilt scale with the 8,300-μsec point (corresponding to the half-cycle duration of a 60-cycle square wave) on the t scale. The straightedge will cross the RC scale at approximately 410,000 ohm-μf. The corresponding low cutoff frequency f_L is found to be 0.4 cycle.

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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

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Four-Tetrode F-M Power Amplifier

ONE apparently satisfactory solution to the problem of obtaining appreciable power output on the new 88- to 108-mc f-m broadcast band has been made by James A. Day of Radio Engineering Laboratories who employs four Eimac 4-1000A tetrodes in a unique tuned-line amplifier.

Although available for some time in limited numbers for experimental work, the type 4-1000A, an internal anode, glass-envelope tube of conventional appearance, is now going into production so that design of a commercial circuit about it is practicable.

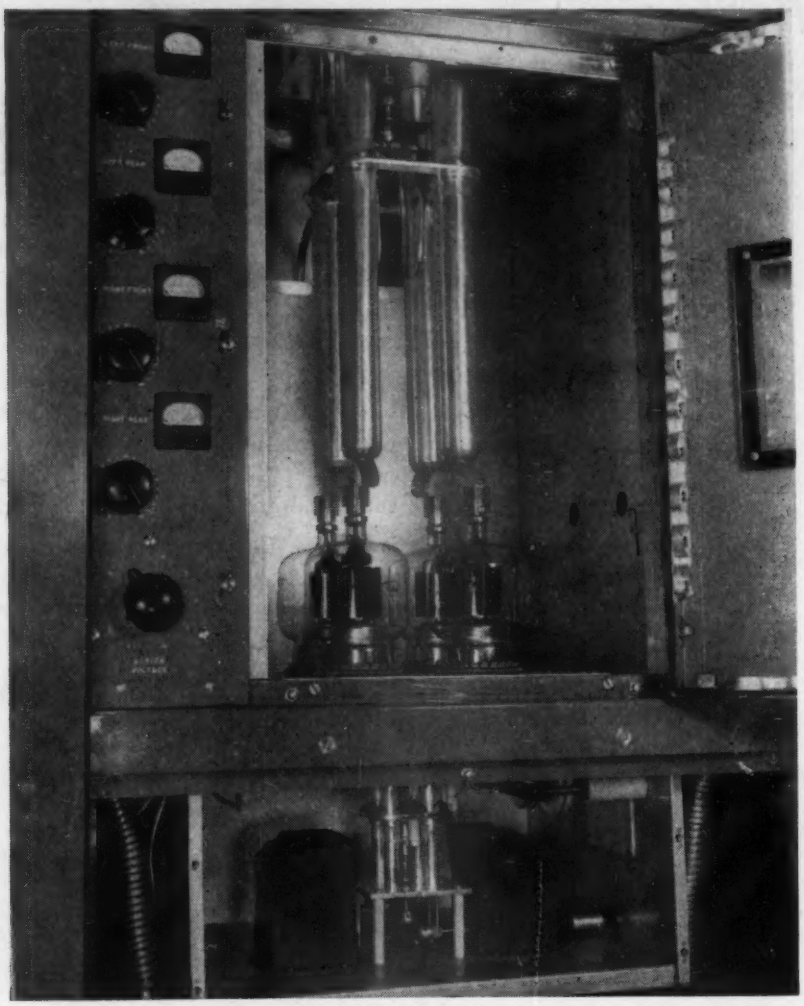

FIG. 1—Interior view of the plate and grid (lower) tuning sections of the novel 10-kw power amplifier for f-m broadcasting

The use of tuned quarter-wave lines has been common practice in vhf oscillator and amplifier circuits for some time. Since a quarter wavelength at 100 mc for parallel lines is in the order of 29 inches, the physical dimensions required are entirely within reason for commercial f-m broadcast amplifiers. Designs now in use employ many of the possible variations, including concentric lines. The four-wire system described here provides both a simple mechanical assembly and excellent self-shielding. A fluorescent desk-lamp tube held within an inch of the tank fails to light when the transmitter is operating at full power.

Figure 1 illustrates the mechanical simplicity, particularly in the plate-tank tuning. The four lines are attached to a square metal plate that hangs from insulators and the plate voltage is fed through the lines to the tubes. Another metal plate with the center cut out can be moved up or down and contact fingers short out the upper parts of the lines for tuning. The coupling coils for taking off power are mounted on a plate of insulating material and are let down through the aperture in the tuning device. The grid tank tuning and input coupling devices are substantially the same.

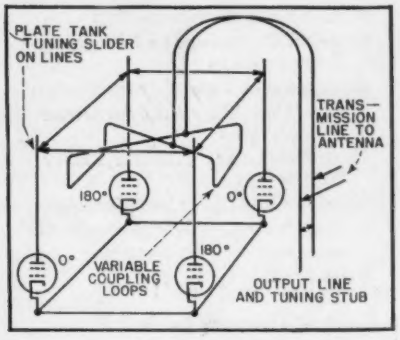

FIG. 2—Simplified sketch showing arrangement of the plate tank circuit and relative phases of the four tuning lines; coupling pickup loops and method of tapping on load are indicated

The electrical aspect of the plate tank circuit is shown in the simplified sketch in Fig. 2. As indicated, each line is relatively phased 180

THE ELECTRON ART

Edited by FRANK ROCKETT

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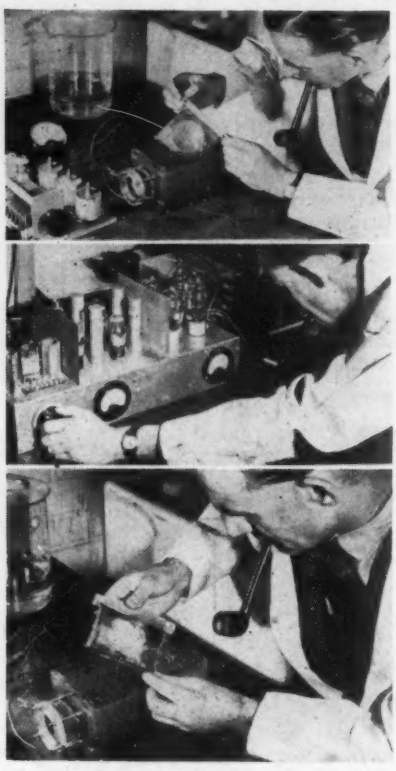
Laundering Ultrasonically

FABRICS have been successfully laundered by scientists of the British Launderers Research Association using ultrasonic vibrations. Whereas particles loosened by soap may not be rinsed from the fabric, ultrasonic vibrations not only overcome the electrical charges holding dirt particles to fabric, but also force the particles from the fabric. The ultrasonic technique is both more effective and quicker than conventional methods of washing fabrics.

Test fabrics that have been experimentally soiled are inserted in the laboratory tank, as shown in the top frame of the picture. The driving transducer can be seen at the left on the tank. John Bold, senior electrical technician shown in the pictures, adjusts the frequency of the oscillator; tests have been carried out up to 300 kilocycles and will be continued up to one megacycle to determine the effect of frequency on cleansing. At the bottom, the test fabric is removed 10 minutes later; note the difference in color of the test cloth between the top and bottom pictures showing the cleaning action.



Laboratory tests indicate that ultrasonic laundering is feasible

Pulse Code Modulation

FREEDOM FROM NOISE and interference in long-distance telephone communication is obtained by a novel form of pulse modulation developed at the Bell Telephone Laboratories. The technique, pulse code modulation (pcm), is expected to find its greatest application with sampling types of transmission over microwave radio relay communications systems. In pulse code modulation, the continuous voice signal is sampled for roughly a millionth of a second 8,000 times a second, giving an upper frequency limit of between 3,000 and 4,000 cps. The instantaneous amplitude of the signal, as determined by the momentary sampling, is converted into one of 32 five-pulse code groups. The code groups constitute the pulse subcarrier with which the microwave radio carrier is modulated. At the relay stations the code groups can be regenerated despite considerable interference. At the receiver they are reconverted into the voice signal. Tests using an eight-channel system showed that the reconstructed voice signal loses negligible fidelity through this method of pulse modulation. Code groups with more pulses can be used if greater fidelity is required; higher sampling rates can be used if higher frequencies are to be transmitted.

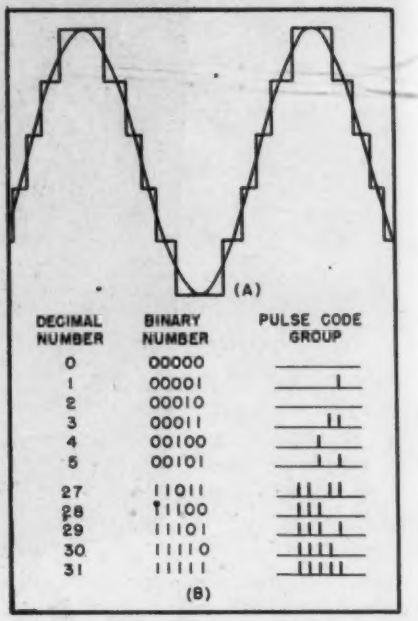


FIG. 1—Instantaneous amplitude of signal is represented by a finite number of discrete steps (A). Using 32 such steps to represent the full range from positive to negative requires a five-pulse code group (B)

Amplitude Quantization

Pulse code modulation samples the signal into discrete amplitude levels as illustrated in Fig. 1A. To

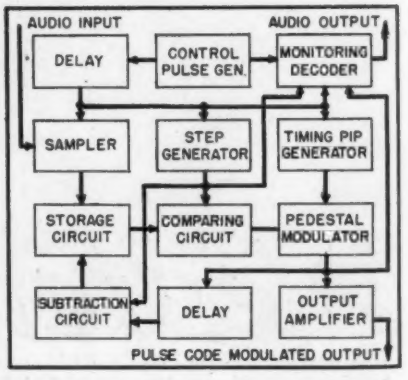
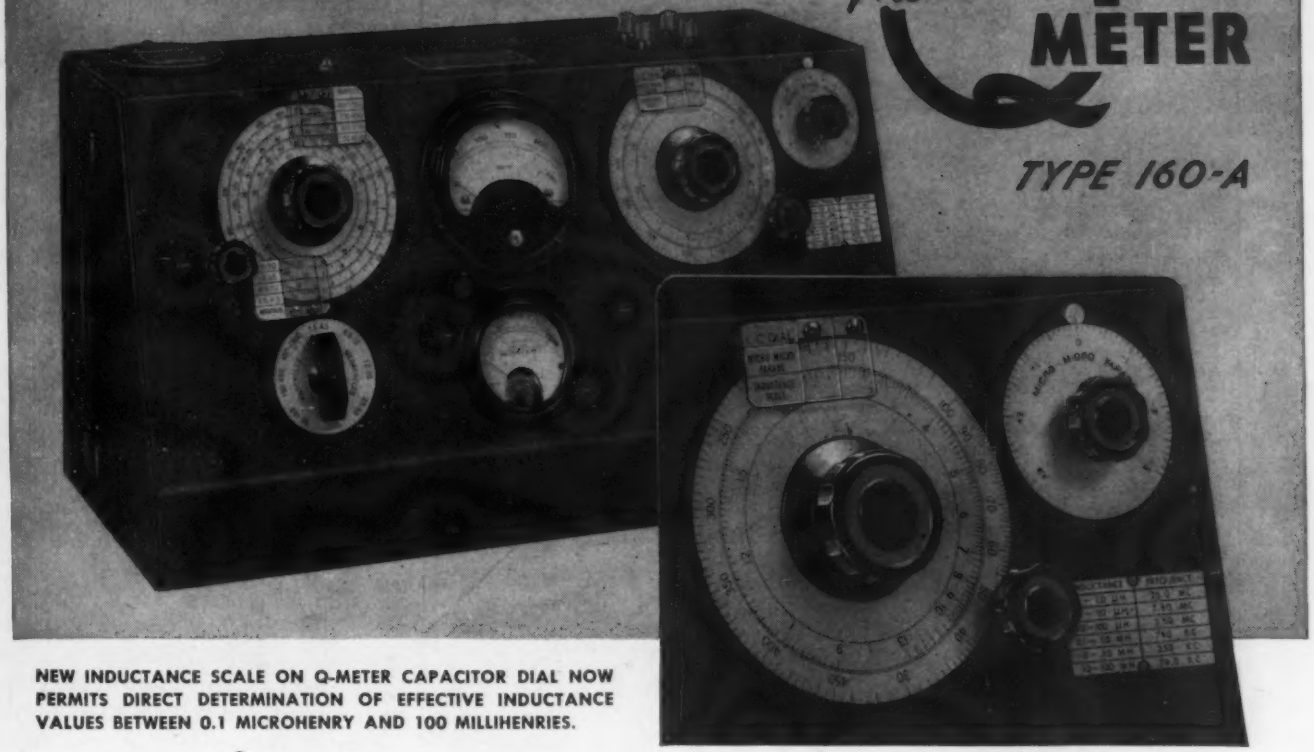


FIG 2—Block diagram of transmitter pulse code converter

A New L-C Dial for The Q METER

TYPE 160-A



NEW INDUCTANCE SCALE ON Q-METER CAPACITOR DIAL NOW PERMITS DIRECT DETERMINATION OF EFFECTIVE INDUCTANCE VALUES BETWEEN 0.1 MICROHENRY AND 100 MILLIHENRIES.

ENLARGED VIEW OF NEW L-C DIAL SHOWING EFFECTIVE INDUCTANCE SCALE. REFERENCE PLATE MOUNTED DIRECTLY BENEATH VERNIER CAPACITOR DIAL SHOWS INDUCTANCE TUNING RANGE OBTAINABLE AT INDICATED SPOT FREQUENCIES.

The 160-A Q-Meter is universally recognized as a rapid and simple means for measuring effective inductance. The customary method of measurement employed by engineers is to resonate the coil under test at a known frequency using a known capacitance, and thus obtain the effective inductance value of the coil by calculation. The use of the new L-C dial, as explained below, further increases the speed and versatility of the 160-A Q-Meter by eliminating the necessity for inductance calculations.

Since the Q capacitor of the 160-A Q-Meter has a capacitance range of somewhat more than 10:1, it is evident that inductance values over a 10:1 range can be resonated at any single frequency. It is, therefore, possible to include on the Q capacitor dial a single decade inductance scale reading directly in terms of effective inductance provided that the proper measurement frequency is selected. The new L-C dial is based on this principle.

An inductance-frequency reference plate has been provided on the front panel which shows the proper frequency to which the RF oscillator should be set in order to obtain the inductance measurement range desired. Any one of six consecutive inductance tuning ranges may be selected, permitting overall inductance measurements of from 0.1 microhenry to 100 millihenries to be made.

For those 160-A Q-Meter owners who wish to equip their own instruments with the new L-C dial, a dial conversion kit, Type 560-A, is available which contains complete parts, hardware, and instructions for installing this dial without disturbing the calibration of the 160-A instrument.

Write for Catalog "D"

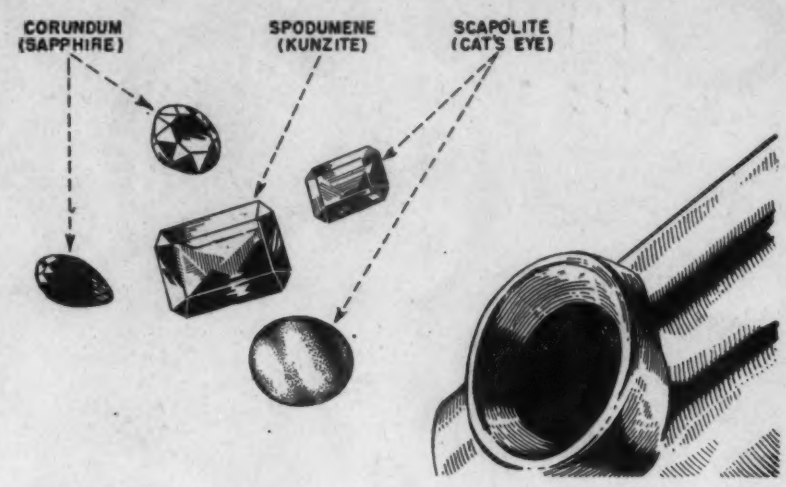
BOONTON RADIO Corporation
BOONTON · N·J · U·S·A

L-C DIAL CONVERSION KIT TYPE 560-A

This conversion kit is available in a unit package, complete with all items required to install the L-C dial on your present 160-A Q-Meter.

Further details upon request.

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS



X-Ray Irradiation of Gems

INTENSE X-RAYS change colors in gem stones. A few stones so affected are identified above (see cover); some 50 are listed by F. H. Pough and T. H. Rogers in *American Mineralogist*, p 37, 32, 1947.

Although it has long been known that x-rays affected colors of some gems, extensive investigations of the effects were time-consuming until Machlett Laboratories developed a 50-kv x-ray tube with a water-cooled tungsten target, and a one-millimeter-thick beryllium window. The beryllium window transmits x-rays of longer wavelength and with less loss than conventional windows. Wavelengths from 0.4 to 4.0 Angstroms are available from this tube. The photograph below shows the water cooling ducts connected on the back of the tube head.

Coloration produced by x-ray irradiation depends on the material, origin of a particular stone, and, to some degree, its cutting. In most instances coloration is only semipermanent; it can readily be removed by heating or exposure to sunlight (infrared). The cause of coloration is associated with redistribution of electrons in the crystals of the stones by the x-rays. Migration of electrons back to their stable positions removes the coloration. If the coloration can be made permanent, it may provide a means of treating gems. In any case the technique affords a means of identifying stones and of studying the physical nature of crystals. The x-ray source has numerous other uses.

For the picture on the front cover, about eight minutes irradiation was required to produce the color changes; tube beam current was 50 ma. Actually the stones are on a glass plate, but the plate, being coated with a nonreflecting surface, is invisible. The x-ray tube lies below the glass, port toward the gems. This technique permitted a close-up of the stones to be taken despite disparity in size between stones and x-ray tube.

each level is assigned a number. These numbers are transmitted by the binary system shown in Fig. 1B. With the five-pulse code groups, about two percent distortion is introduced by the amplitude quantization technique. In the actual system, because of the nature of the voice signal, the steps or quanta levels are logarithmic, being smallest for low levels, thus giving a nearly uniform percentage precision throughout the amplitude range. Using logarithmic steps permits using far fewer steps than would be necessary for the same fidelity if uniform steps were used.

The pcm system using five-pulse groups requires slightly less than five times the bandwidth of a pulse amplitude modulation (pam) system, but is far less subject to cross-talk in a multiplex network. and tolerates a much lower signal-noise ratio.

Figure 2 shows the basic experimental circuit for pcm. The voice signal is sampled into amplitude modulated pulses. Each a-m pulse is stored on a capacitor in the storage circuit, the voltage so produced being compared to a reference voltage. If the capacitor voltage exceeds the reference voltage a positive pedestal voltage is applied to the pedestal modulator which gates the timing pulses from the timing pip generator to give an output pulse, which corresponds to the largest value digit in the binary number. This pulse is transmitted and, in addition, is fed back through the delay and subtraction circuits to subtract a charge from the storage capacitor. The remaining charge is compared to a new reference voltage equal to half the original reference, and, by the same process, a second digit generated. If the sampled pulse amplitude is less than the reference voltage, no pulse is transmitted. At the receiver, the pulse groups are reconverted into the voice signal by subtracting a locally established charge from a capacitor in accordance with the incoming pulses.

Although the system is still in the experimental stage, it has given very acceptable transmission for voice and music. Its chief ad-

(Continued on p 174)

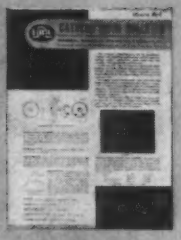
Put This Formula To Work For You

$$I = \frac{E}{IRC}$$

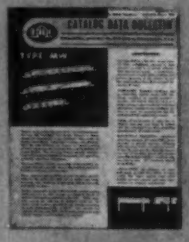
The formula $I = \frac{E}{IRC}$ is a favorite and easily-remembered solution to resistance problems. Radio and electronic Engineers know that IRC offers the most complete line of resistance products in the industry . . . a fixed or variable resistor for most every requirement . . . with uniform dependability proved by years of rigorous laboratory and field tests. Purchasing Agents and material control executives like IRC's service . . . "on-time" deliveries . . . factory stock-piles of the most popular types and ranges from which they can draw in emergency . . . IRC's distributor network, providing speedy, 'round-the-corner service for small order requirements.

Put this formula to work for you . . . check below the catalog bulletins in which you are interested—tear out this page, and mail it to us today with your letterhead, giving your name and title. International Resistance Company, 401 N. Broad Street, Philadelphia 8, Pennsylvania. In Canada: International Resistance Company, Ltd., Toronto, Licensee.

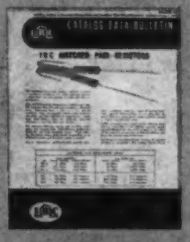
INSULATED COMPOSITION INSULATED WIRE WOUND RESISTORS IRC types BT & BW ☐



FINGER-TIP CONTROLS AND SWITCHES IRC types H & SH ☐



WIRE WOUND RESISTORS IRC type MW ☐



MATCHED PAIR RESISTORS ☐

POWER RESISTORS ☐

FLAT POWER RESISTORS IRC type FRW ☐

VOLUME CONTROLS IRC type DS ☐

WIRE WOUND POTENTIOMETERS IRC type W ☐

VOLTMETER MULTIPLIERS IRC types MFA & MFB ☐

POWER RHEOSTATS IRC types PR & PRT ☐

WATER-COOLED RESISTORS IRC type LP ☐

PRECISION RESISTORS ☐

HIGH VOLTAGE RESISTORS IRC type MV ☐

HIGH POWER RESISTORS IRC type MP ☐

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NEW PRODUCTS

Edited by A. A. McKENZIE

New equipment, components, packaged units, allied products; new tubes. Catalogs and manufacturers' publications reviewed.

Television Tube (1)

GENERAL ELECTRIC Co., Syracuse, N. Y. A 10-inch aluminum-backed, type 10FP4 with magnetic focusing and deflection has been developed for television receivers. Maximum

(anode) voltage required is 10,000 volts. Further details are obtainable from the Tube Division.

Geiger Tube (2)

GEOPHYSICAL INSTRUMENT Co., 1820 N. Nash St., Arlington, Va. A new all-metal Geiger counter tube with a low background and an operating potential of about 1,000 volts is now

available in a variety of sizes from a half inch to 5 feet long and in diameters of a half inch to 3 inches. Tubes can be supplied separately or with auxiliary systems.

Dual Speaker (3)

ALTEC LANSING Corp., 250 West 57th St., New York 19, N. Y. A new loudspeaker with a frequency range of 50 to 15,000 cycles has separate woofer and tweeter in a coaxial construction. The unit is so

designed that it can be built into existing cabinets or installed in the wall of a room. The high-frequency section uses a multicellular horn.

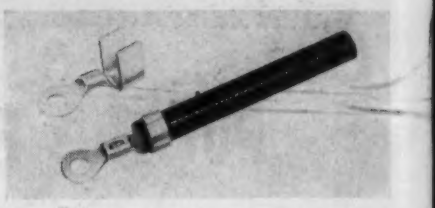
Vibration Mount (4)

HAMILTON KENT MANUFACTURING Co., Kent, Ohio, announces a new light-duty vibration mount to isolate vibration in radios, test apparatus, and the like. These Rexon

mounts are furnished in strips twelve inches long and may be used entirely or cut into sections, depending on the load to be supported. Additional information will be furnished by the manufacturer on request.

Small-Wire Lug (5)

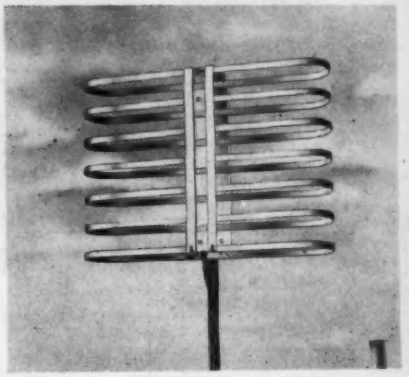
BURNDY ENGINEERING Co., Inc., 107 Bruckner Blvd., New York 54, N. Y.



The lug illustrated is handy for small wires with heavy insulation. Electrical connection is made with pressure and the tabs can be folded about the insulating material.

F-M And Television Antennas (6)

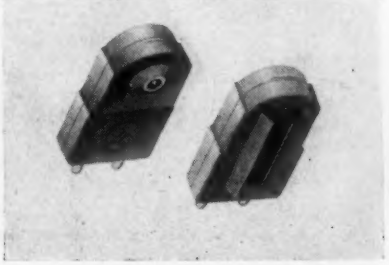
RAULAND CORP., 4245 North Knox Ave., Chicago, Ill., has released the first of a new line of f-m and television antennas to the radio industry. The model 150, with an omni-



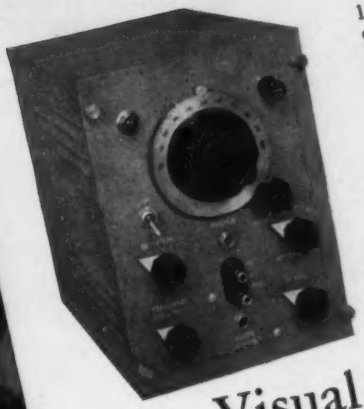
directional pickup and high sensitivity, is designed specifically for use on the 88 to 108 mc f-m band. Constructed entirely of aluminum and small in size, it contributes to low wind resistance. Additional models will be released in the near future.

Phonograph Cartridge (7)

PICKERING AND Co., Inc., 29 West 57th St., New York 19, N. Y. A new cartridge for home phonograph use requires a pressure of a half ounce and gives a flat response from 40 to 10,000 cycles. Intermodulation and



Smart Move!



The VISALGEN (shown at left) gives a wide band FM output synchronized with a linear sweep, so that the overall frequency response of the cuit under test is seen on an oscilloscope screen.

Aligns I.F. and R.F. amplifiers in FM and AM Communication and Broadcast receivers, or broad band receivers of any type. Indispensable for FM discriminator and over-coupled circuit alignment.

Visual Alignment

The VISALGEN saves time, because you instantly see the entire frequency response curve.

Available in two models:

205TS (500 Kc. to 20 Mc.) $197.50*

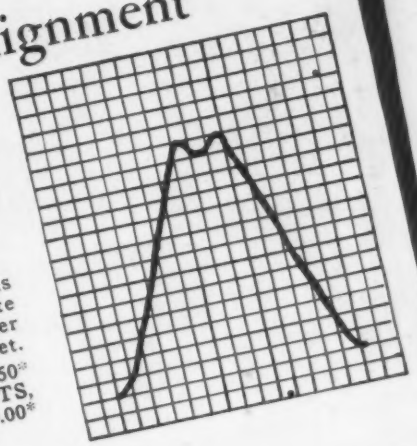
204TS (20 Kc. to 500 Kc.) $197.50*

A matching oscilloscope is also available in a separate cabinet or installed with either VISALGEN in a single cabinet.

188TS oscilloscope $97.50*

204TS or 205TS with 188TS, in same case $290.00*

*F.O.B. Cambridge, Mass.



It's Faster

You see the entire response curve at a glance

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HARVEY RADIO LABORATORIES, INC.

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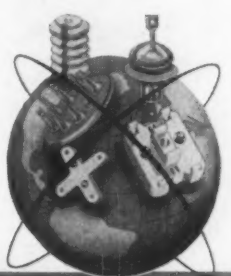
Kovar meets exacting requirements for sealing to glass. Here are a few outstanding features:

1. For use with hard glass, having high thermal shock properties and permits high temperature evacuation.
2. Matches expansivity of the glass over entire temperature range (up to the plastic state of the glass) resulting in strain-free seals.
3. Resists mercury attack.
4. Not subject to size limitations (seals have been made with Kovar 12" in diameter and ⅛" thick).
5. Readily seals with simple oxidation procedure.
6. Mechanical strength—full metal thickness without "feather edge."

Kovar has gained world-wide acceptance and is used by leading American and foreign manufacturers. It is easily machined or cold formed and is available in all desired shapes—sheet, strip, foil, wire, rod, leads, tubing, cups, eyelets and flanges.

When writing for literature, please state the nature of your proposed application.

Write for Literature



*Trade Mark No. 337962
Westinghouse Pat. No. 1,942,260 and others

STUPAKOFF

CERAMIC AND MANUFACTURING CO. · LATROBE, PA.

EXPORT DEPARTMENT: 13 E. 40th Street, New York 16, N. Y. · Cable Address ARLAB, all codes

harmonic distortion are extremely low. Output voltage for a stylus velocity of 10 centimeters a second is 70 millivolts. A permanent sapphire stylus is provided. One feature of the unit is a clip that allows attaching the cartridge to the pickup arm of practically any record player.

Synchronous Timer (8)

AMERICAN TIME Corporation, Springfield 1, Mass. The Chronolux, a new synchronous timer for darkrooms, works by automatic control

of the exposure interval. Simply operated and automatically reset, it can be used on 110 volts, 60-cycle, with a 1,000-watt capacity. Retail price is $16.78.

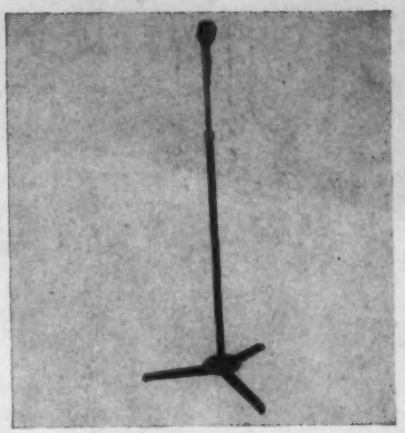
High-Voltage Resistors (9)

RESISTANCE PRODUCTS Co., 714 Race St., Harrisburg, Pa. Now in production, the type B high-voltage resistors can be made in resistance values as high as a million megohms.

They might be used in high-voltage probes for v-t voltmeters. Applications will be found in television, x-ray circuits, and other electronic fields.

Mike Stand (10)

ELECTRO-VOICE, Inc., Buchanan, Mich. The model 430 button-control



floor stand is easily adjusted to the desired height and the attached microphone can be rotated at will. Height adjustment ranges between 36 and 65 inches. Write for Bulletin 134.

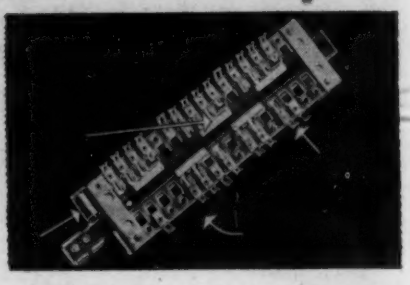
F-M Transmitter-Receiver (11)

GENERAL ELECTRIC Co., Syracuse, N. Y. New 60-watt f-m transmitter-receiver combination equipment for fixed station use can be remotely operated over a single pair of tele-

phone wires. The type SC-9 uses one or two receivers for police, power, forestry and public utility service.

Slide Switch (12)

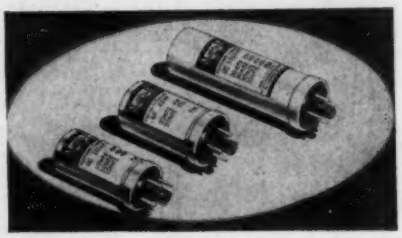
CENTRALAB DIVISION of Globe-Union, Inc., Milwaukee 1, Wis. A new slide switch is designed for improved a-m and f-m performance permitting coils to be mounted directly over the switch thereby reducing lead inductances for low and



high frequency switching efficiency. The unit is available with either two or three-position index. Double wipe clips assure constant pressure and low internal resistance. Complete technical data is contained in Bulletin No. 953.

Plug-In Capacitors (13)

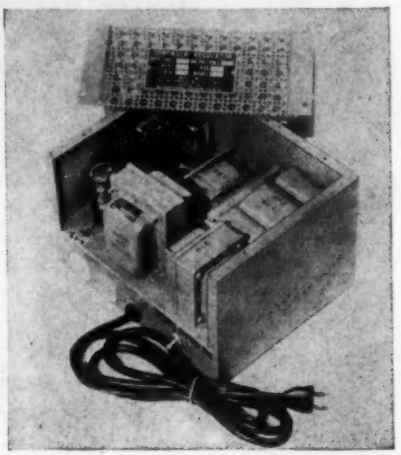
CORNELL-DUBILIER ELECTRIC Corp., South Plainfield, N. J. Type QC capacitors are hermetically sealed in round aluminum containers and are provided with a four-pin octal base



mounting for easy removal. Complete specifications are given in Bulletin 100-425.

A-C Voltage Regulator (14)

SORENSEN AND Co., 375 Fairfield Ave., Stamford, Conn. The new model 150 voltage regulator has an input range of 95 to 125 volts a-c with an output of 115 volts. Regu-



(continued on p 194)

Magnavox...

Component headquarters since 1915

FOR more than three decades Magnavox has served the radio industry, specializing in the quantity production of quality components for the manufacturing trade.

Manufacturers know that their finished products can be only as good as the parts they use. To insure dependability, economy and customer satisfaction, they insist upon Magnavox components—long established as the highest standard of quality.

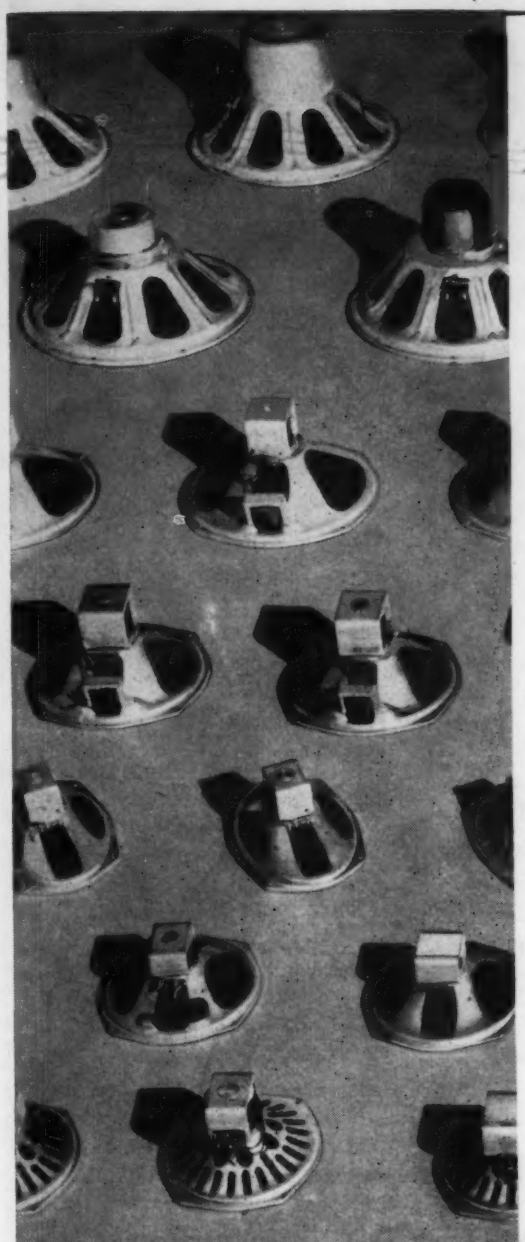
Over 100 different speaker models are made to supply every possible production need. Capacitors and other component parts are highly perfected and standardized into container sizes right for every type installation.

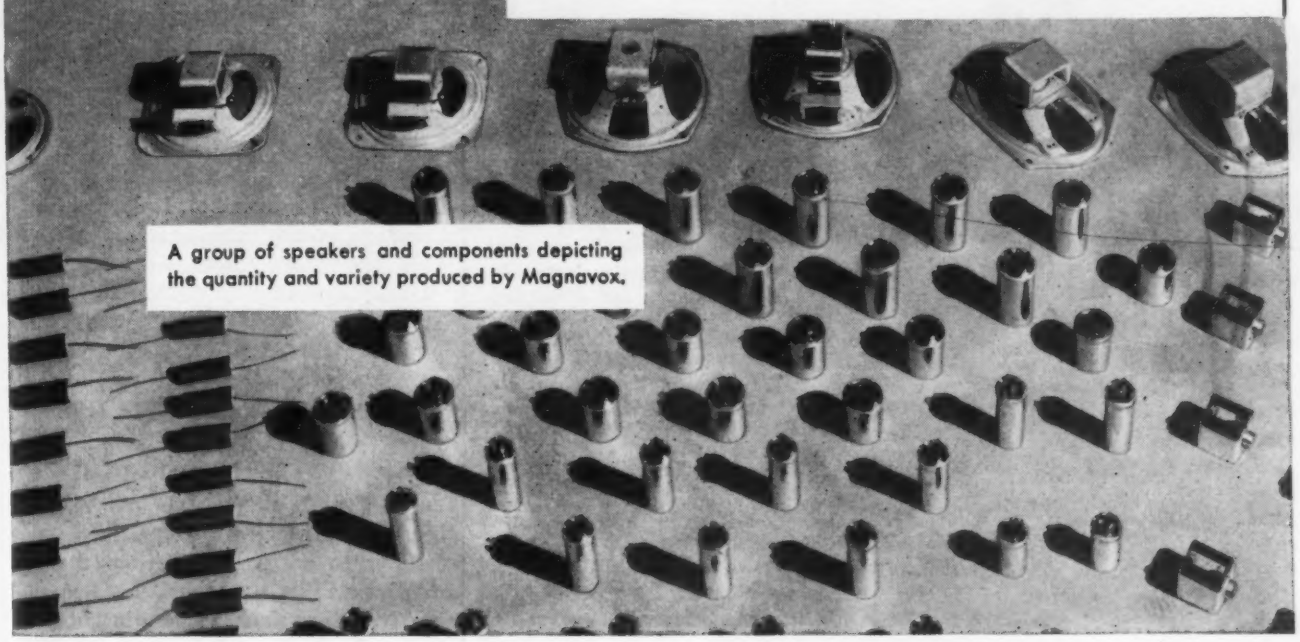
In the modern, six-acre Magnavox plant, experienced engineers and designers stand ready to apply their skills to any of your component problems. When you need loudspeakers, capacitors or other components, ask for Magnavox, and your specifications will be met exactly. There is no substitute for experience! The Magnavox Company, Components Division, Fort Wayne 4, Indiana.

Magnavox

has served the radio industry for over 32 years

SPEAKERS • CAPACITORS • SOLENOIDS • ELECTRONIC EQUIPMENT





A group of speakers and components depicting the quantity and variety produced by Magnavox.

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Meetings to come; new tube standards; relay manufacturers organize; experimental radar lab; index to wartime reports; business expansion

Current Status of F-M Stations

MORE THAN 500 different communities in 47 states, the District of Columbia, and Puerto Rico are in the service areas of nearly 1,000 authorized or projected frequency-modulation broadcast stations.

Some 215 f-m stations are now on the air. Construction permits or conditional grants have been issued by the FCC to nearly 800 new stations, and more than 200 applications are pending.

International Recommendations for Marine Electronic Aids

RECOMMENDATIONS and conclusions of IMMRAN—the recent International Meeting on Marine Radio Aids to Navigation where 92 representatives from 31 maritime nations gathered in New York City and New London, Conn. to discuss the application of electronic aids to navigation and pilotage—are embodied in a three-part final report covering marine radar (reported in ELECTRONICS, p. 144, July 1947), position-fixing, and comprehensive radio aids. The latter two sections of the report are abstracted here.

Position-Fixing Systems

Development and adoption of equipment and systems for marine navigation should be guided by the accompanying table of desired accuracies and available times for determination of position, in relation to the approximate distances off shore and/or depths of water under the keel.

A position-fixing system is required for safe entry into the zone at which radar becomes effective, bearing in mind that the extent of such a zone varies with the adequacy of the radar targets available.

Although the system of medium-frequency d-f and associated radiobeacons may not fully satisfy the requirements set out in the table, it can continue to fulfill a useful function in making landfall and in coastal navigation, as well as for search and rescue requirements. The system should be periodically reviewed in comparison with the then existing needs of the marine user in regard to coastal areas.

Existing systems of radiobeacons provided for use in conjunction with shipborne medium-frequency d-f should be maintained universally at a standard not below that at present provided. In certain areas, notably those where such systems are established, they should be improved and expanded.

Decca, provided it continues to give operational satisfaction and that the application of lane identification proves effective, appears to provide a position-fixing system of an accuracy which meets the mariner's requirements, and therefore should be improved and expanded in regions where the nations concerned consider it desirable.

A long-range navigational aid, while desirable for certain marine services, cannot be regarded as having the same priority as medium-distance navigational aids. The long-range aid requirements of aviation are the most pressing, but in determining the most appropriate long-range aeronautical aid it will be to the mutual advantage of both air and marine interests if due weight is given by the former to the relative advantages of the different long-range aid systems from the marine point of view.

If the effective coverage area of a system be taken as that within which the system gives a usable signal-to-noise ratio, standard loran gives higher accuracy within its effective coverage area than does Consol within its larger effective coverage area. Therefore, as a long-range navigation system, standard loran should be continued and improved.

Comprehensive Radio Aids

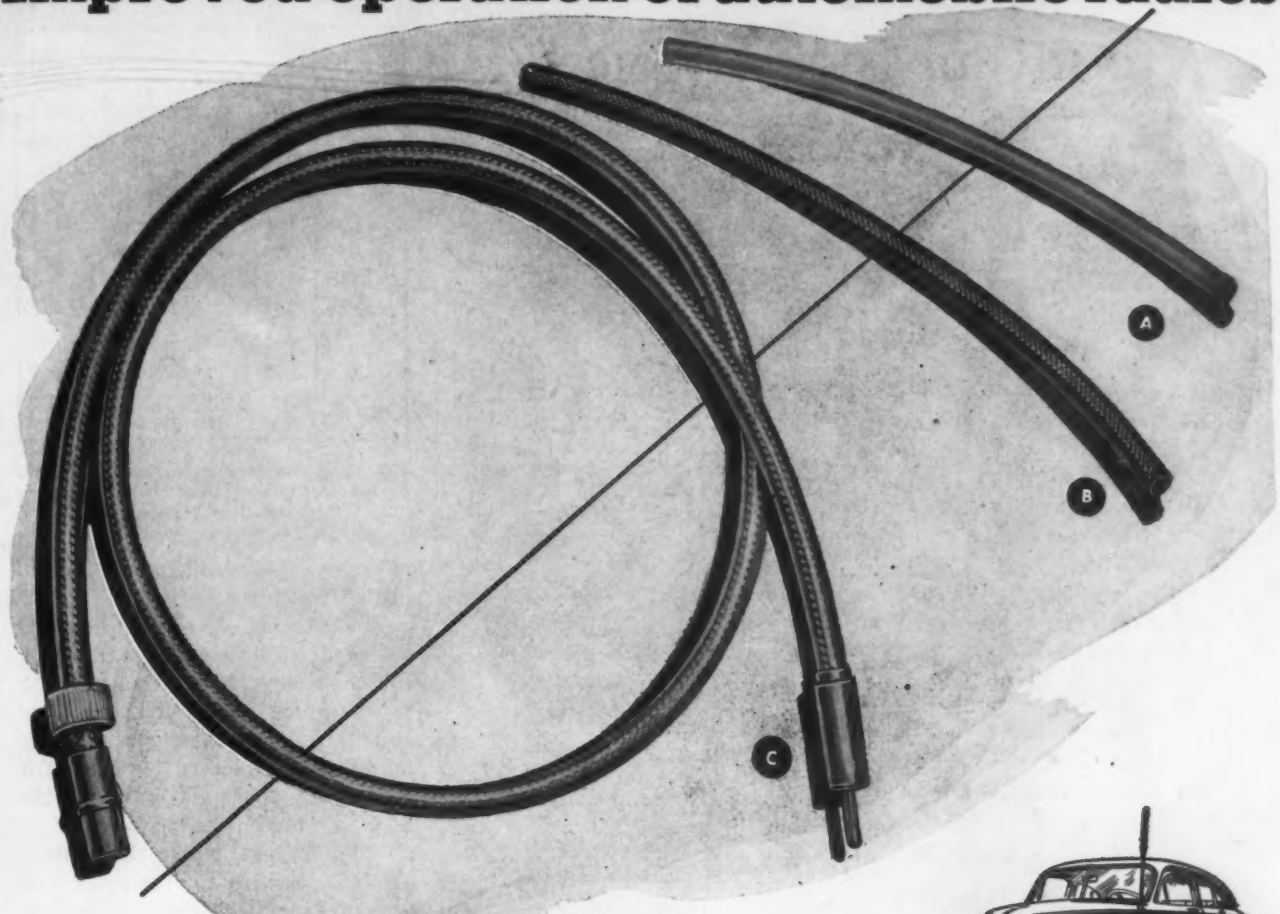
It is recommended that an international standing committee be set up for the purpose of making information available to the user upon request, and to have such information available for an appropriate future international conference or organization. This committee would include scientific experts to obtain and coordinate numerical data on the performance of various radio navigational aids. The Governments of the United States and the United Kingdom are invited jointly to study the means of implementing these recommendations.

2. It is recommended that each administration undertake or continue studies and analyses, and pre-

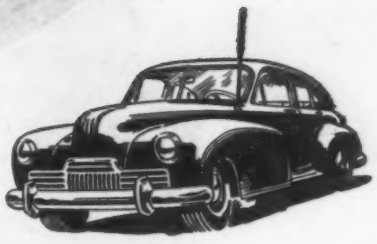
Desired Specifications for Electronic Aids to Marine Navigation

Function	Depth of water	Distance from nearest danger	Accuracy required	Time available to obtain position
Aid to ocean navigation	Over 100 fathoms	Over 50 miles	± 1 percent of distance from danger	15 minutes
Aid to approaching coastal navigation and port approach	20–100 fathoms	Between 50 miles and 3 miles	± ½ mile to ± 200 yards	5 minutes to ½ minute
Aid to harbor entrance	Up to 20 fathoms	Less than 3 miles	±50 yards	Instantaneous position and track required

Improved operation of automobile radios



with radio antenna lead-in cable insulated with Du Pont POLYTHENE



Now, with the use of Du Pont polythene, it is possible to make a lead-in cable, from the antenna to the instrument, that helps to assure proper operation of automobile radios—a lead-in cable that is water-tight, has excellent electrical properties, is economical to assemble, and gives long service.

Du Pont polythene has been successfully used as the insulating material for the shielded lead-in tubing made by The American Brass Company, Waterbury, Conn., because it has low capacitance and is usable over a wide range of temperatures. In addition, Du Pont polythene has these other outstanding advantages:

RESISTANCE TO MOISTURE—Polythene has low moisture permeability, protects the cable from short circuits caused by moisture.

LASTING FLEXIBILITY—Polythene withstands twisting and bending over a wide range of temperatures.

HIGH "Q"—Electrical losses within a polythene-insulated cable are negligible.

EASE OF HANDLING—Polythene has good extrusion qualities, is economical to assemble.

Your insulating problem may be solved by using Du Pont polythene. Write us for complete information on this light-weight, durable insulating material. E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept. 148, Arlington, N. J.

A Extruded tube of Du Pont polythene, Type PM-1, 0.125" I. D. x 0.200" O. D. (one of many sizes), used for inner core of shielded lead-in tubing for a radio antenna. Polythene is ideal for this core because it is easily extruded, retains electrical properties.

B Tinned copper basket-weave braid is woven over inner core of polythene to incorporate electrical properties necessary in shielded lead-in tubing.

C The outer jacket, Type PM-2 polythene, about 35 mils thick, adds neat appearance, seals out water.

Du Pont manufactures polythene molding powder. Commercial extruders convert polythene into the forms of

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Plastics
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

pare proposed minimum standards, for radio aids to navigation equipment other than radar.

3. It is recommended that each Administration ensure the institution of an adequate personnel training program for efficient operation and maintenance of radio aids to navigation equipment.

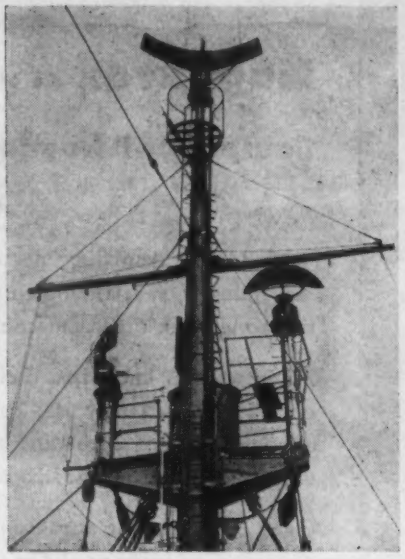
Tolerance of components and design of equipment should be such that when components are interchanged no realignments become necessary which would require special apparatus or skilled personnel.

Dimensions and electrical characteristics of main components (such as magnetrons, local oscillators, crystals, tubes, and transformers) should be standardized.

In view of the importance of radio aids to safe marine navigation, adequate provision should be made to meet the requirements of mariners at the International Telecommunications Conference.

VHF radio telephony will provide the maritime service with a valuable means of navigational communication for ship to ship and ship to shore, within the range allowed by the choice of frequency.

Requirements of the maritime service for harbor control of shipping, safety, distress, and navigational communications on rivers and lakes as well as on the coasts of the various countries suggest that at least one two-way circuit in the 150-160 megacycle region should be adopted as standard. There should also be international standardization respecting the type of modulation to be employed and the characteristics thereof.



Foremost of U. S. Maritime Commission's training vessel, AMERICAN SAILOR, showing three of the five radar scanners installed for IMMRAN demonstrations. Those shown are Raytheon at top, Radiomarine at lower left, and Sperry at lower right. Westinghouse scanner was on aftermast, and General Electric scanner was on top of wheelhouse

If it proves desirable to standardize on two frequencies for this purpose, consideration should be given to the possibility of separating them by some difference such as five megacycles.

International agreement should be secured on allocation of frequencies for at least one two-way communication circuit. If possible, further allocations should be agreed internationally for a second such circuit, should the first prove to be insufficient in the vicinity of 160 mc.

Each country should establish appropriate machinery to coordinate air and marine interests, so that delegates to international meetings on either marine or air radio aids may speak with the interests of both in mind.

No monopolistic practices should prevent any country from manufacturing radio aids to navigation that have been agreed internationally as of proven value to the mariner.

Radio Aids to Tennis

TESTS of a radio aid for tennis instruction were authorized by the FCC in granting a construction permit for an experimental class 2 portable station, with power output of 1 watt on 27.44 mc, to Charles G. Lungren who is working at the University of Miami with tennis coach Mercer Beasley.

A student being coached would wear a small receiver attached to the small of his back and diminutive earphones resembling those employed for hearing aids. The initial use of the portable equipment will be for one-way communication with players during games to prevent interruptions of play during instruction.

RMA Elects Officers, Expands Services

EXPANDED services to help radio manufacturers readjust their operations to postwar conditions were authorized by the new RMA Board of Directors at the concluding busi-

(continued on p 234)

MEETINGS

AUG 26–29: AIEE 1947 Pacific General Meeting, Hotel San Diego, San Diego, Calif.

SEPT. 8–12: Second Annual Conference and Exhibit of The Instrument Society of America, at Stevens Hotel, Chicago.

SEPT. 15–18: Annual convention, National Association of Broadcasters, Atlantic City, New Jersey, with exhibits in Convention Hall.

SEPT. 23–25: AIEE Middle Eastern District Meeting, Dayton, Ohio.

Sept. 24–26: West Coast IRE Convention, Palace Hotel, San Francisco, Calif., Prof. Karl Spangenburg, general chairman, Stanford University, Palo Alto, Calif.

SEPT. 26–28: Third annual Electronics Trade Show, Hotel Whitcomb, San Francisco, sponsored by West Coast Electronic Manufacturers' Association, W. Noel Eldred, secretary, care of Hewlett-Packard Co., Palo Alto, Calif.

SEPT. 26–28: Hudson Division ARRL Convention, Convention Hall, Asbury Park, N. J.; technical papers and exhibits of electronic equipment for radio amateurs.

SEPT. 29-OCT. 2: Annual meeting, International Municipal Signal Association, Inc., Pantlind Hotel, Grand Rapids, Michigan; technical papers and exhibits of police and fire radio equipment.

SEPT 30-OCT. 11: National Radio Exhibition, Olympia Hall, London, sponsored by British Radio Industry Council and featuring new British radio, electronic control, radar, and television equipment.

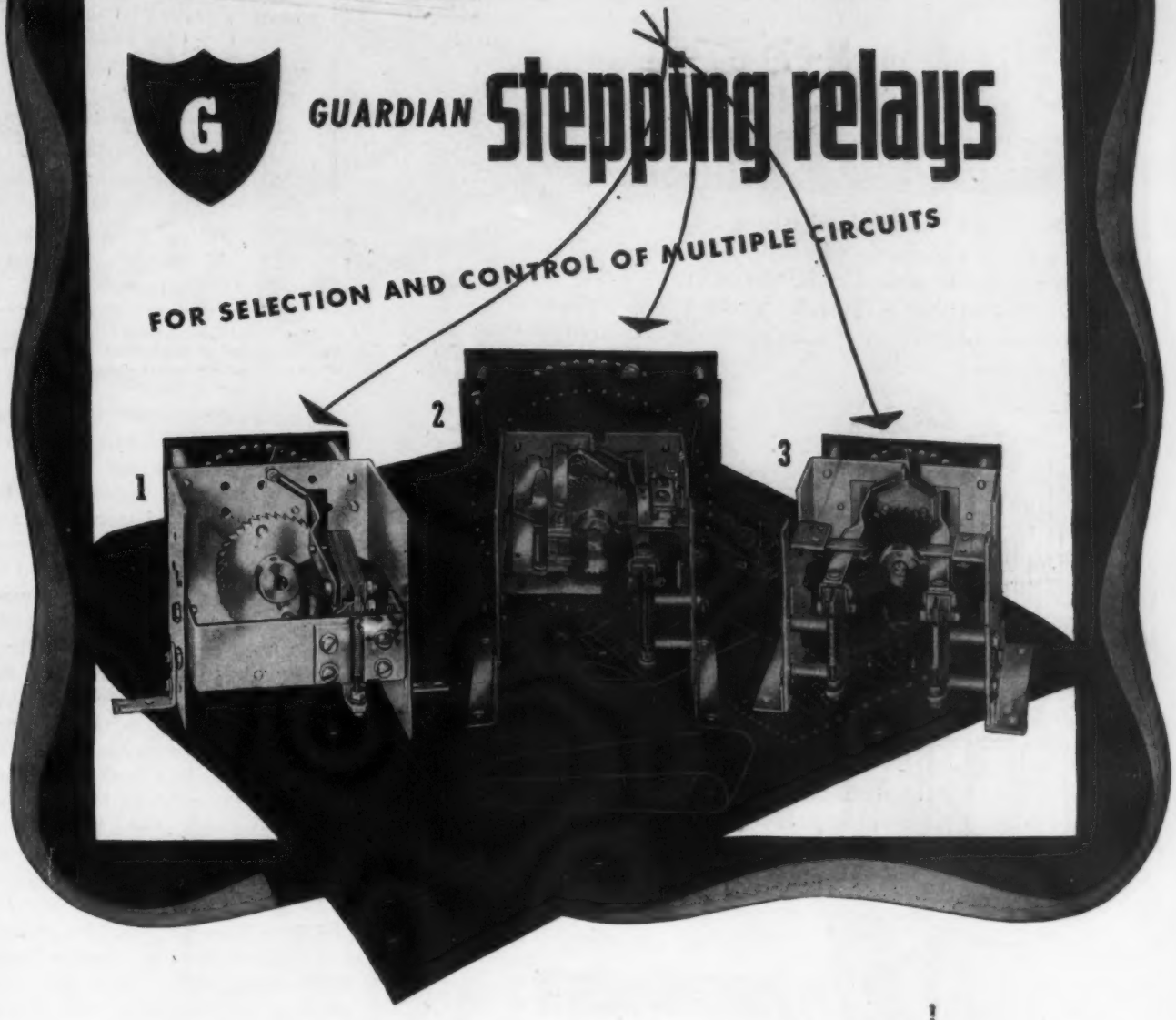
OCT. 23–25: Annual Meeting Optical Society of America, Netherland Plaza, Cincinnati, Ohio; symposium on microwave optics.

Nov. 3–5: National Electronics Conference, Edgewater Beach Hotel, Chicago.

Nov. 3–7: AIEE Midwest General Meeting, Chicago, Ill.

GUARDIAN stepping relays

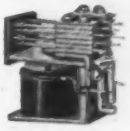
FOR SELECTION AND CONTROL OF MULTIPLE CIRCUITS



This trio of standard Guardian Stepping Relays: (1) continuous rotation, (2) electrical reset, (3) add and subtract—will start you off with a minimum of design and keep your product operating indefinitely. The Guardian Steppers shown are adaptable to numerous applications: automatic circuit selection; automatic sequence selection of circuits; automatic sequence cross-connection of circuits. They are used in automatic business machines, production totalizers, conveyor controls, animated displays, telephony, remote tuning, with a host of additional uses you will soon discover. On each, the contact finger rotates counter-clockwise. All three Steppers follow 10 pulses per second within the rated voltage range of the relay. Special construction prohibits skipping or improper indexing of the ratchet. Available in separate units or in combination with relays, contact switches, solenoids; completely assembled and wired to terminals; mounted on special bases or in enclosures. "Special" modifications are obtainable in production quantities. Write for Bulletin SR.

Series 100 Snap-Action Relay

Guardian Featherub Switch



Series 500 Midget Relay

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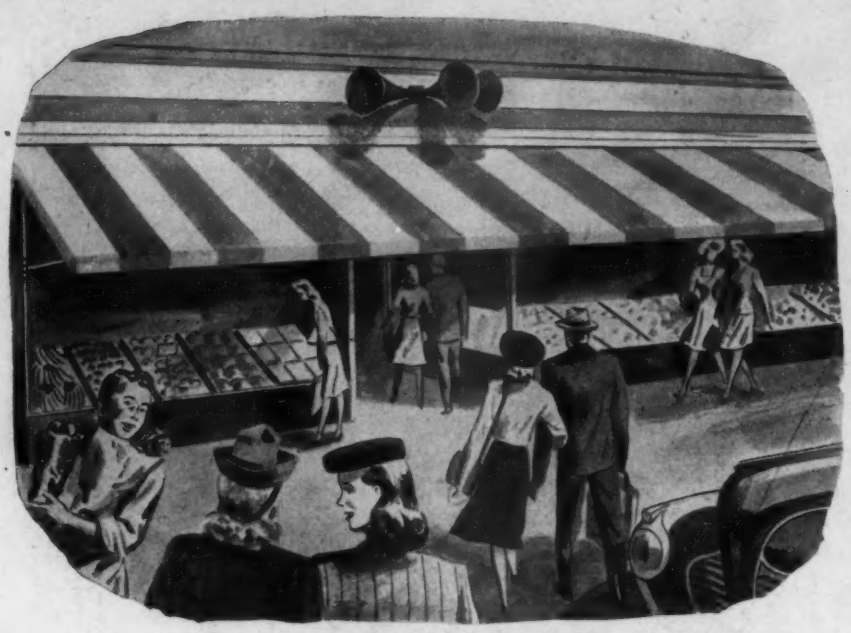

We mean advertising in stores by *continuous* Magnetic Recording . . . "Advoice" is just a name . . . call your instrument anything you wish! The idea is *sound*. Why not put grocery specials on wire recordings? Or maybe you've got a better idea. If our thought or your inspiration prompts a design for a wire recorder, remember what Brush wire recording components offer:

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Brush Wire Recording Heads

Of principal interest are their excellent electrical characteristics, extreme simplicity of design to avoid trouble, and the "humbucking" characteristics, which reduce the effect of extraneous magnetic fields. When required, the head cartridge alone (pole piece and coil unit) may be supplied for incorporation into manufacturers' own head structure.

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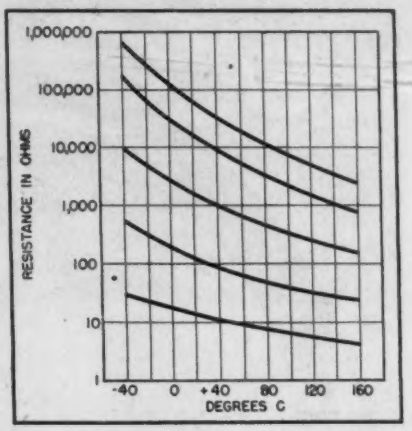

FIG. 1 — Resistance-versus-temperature curves for typical negative temperature coefficient resistors

abled by the resulting subnormal heater voltage.

The growing use of selenium rectifiers has focused attention on these problems, for the rectifier tubes which were displaced had acceptable (though operationally not too satisfactory) means for connecting the pilot light in the form of a tap on the heater.

The falling resistance-temperature characteristics of negative-temperature-coefficient resistors, also known as semiconductors, thermal resistors, or thermistors, make possible an improved solution to the pilot light-heater circuit problem, and resistors of this type have recently been designed into radio receivers for current production.

Figure 1 shows the resistance of typical one-watt Keystone NTC units as a function of temperature. The temperature coefficient of resistance is negative, is much higher than that of ordinary metallic conductors, and depends upon the temperature. The NTC units are produced from rare earth oxides in values ranging from 1.0 ohm to 1 megohm at room temperature. The size and shape of the piece may be varied over a considerable range to achieve suitable electrical and thermal properties.

Circuit Operation

If an NTC resistor is connected in series with other circuit resistance, the initial total resistance will be the sum of those due to the unit at ambient temperature and to the remainder of the circuit. If voltage is applied across the circuit,

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Coils are available in inductances from 1 MHY to 12 HYS.

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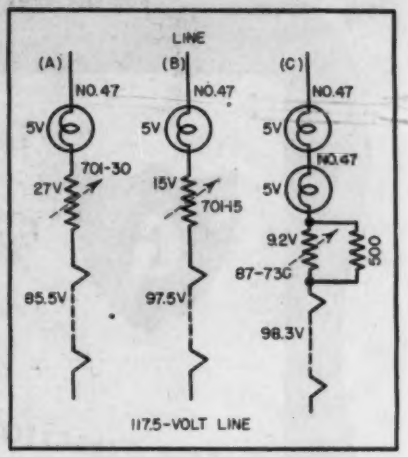

FIG. 2—For 150-ma heater tubes, the negative temperature coefficient resistors act as the only voltage dropping unit

the initial current will be that corresponding to the above initial resistance. However, the I^2R loss in the resistor unit immediately begins to elevate its temperature and there is an accompanying and corresponding fall in resistance and an attendant increase in current. These changes continue progressively until equilibrium is reached, after which the current and the temperature and resistance of the unit remain at the equilibrium value. This value may be defined as that corresponding to the condition for which the attained temperature rise of the unit above its ambient is sufficient to produce heat loss at the same rate as electrical energy is being supplied.

The cold resistance of vacuum-tube heater circuits is exceedingly low compared with the normal continuous operation value, and hence there is a heavy current surge at switch-on. The pilot light, with its relatively small and fragile filament which is continuously evaporating in service, is less well adapted to withstand surges of the order of three to four times rated current, with the result that conventional series arrangements of pilot light and heater lead to burn-outs much earlier than is the case for more nearly constant voltage operation.

Figures 2 and 3 shows a number of practical circuits for 150 and 300-ma heater strings in combination with one or two type 47 pilot lights and suitable resistor units. Many other circuit arrangements are possible with the indicated NTC units or other values; the particu-

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GENERAL TEST EQUIPMENT:

(A) Vacuum Tube Test Equipment — Automatic Production Tube Test Equipment. Electronic Reject circuits provide only positive rejects. Eliminates meters, places quality control in hands of quality control men. (B) Other characteristic test sets for receiving, small transmitting and power tubes, cathode-ray and kinescope tubes. Basic characteristic tests — dynamic and static — and bridge measurements are incorporated. Designed and manufactured to individual needs on custom built basis.

TELEVISION TEST EQUIPMENT:

(A) Television Signal Synthesizer. Includes generating, viewing and transmitting test equipment. Sync generators, monoscopes, shapers, timers, wide band oscilloscopes, air monitors, measuring devices and field survey equipment.

COMPONENT TEST EQUIPMENT:

(A) Focusing and deflection coils. (B) Resistor and condensor testing. (C) Wire and insulation test equipment. (D) Relays, transformers, chokes and other iron components.

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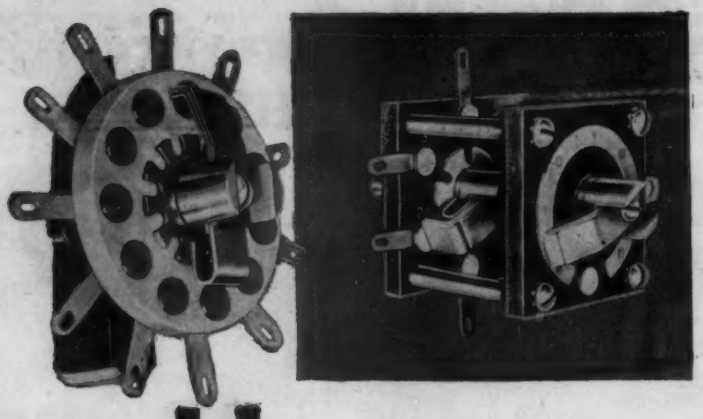

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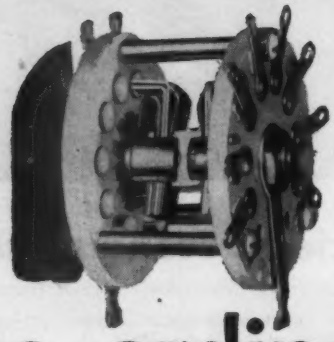
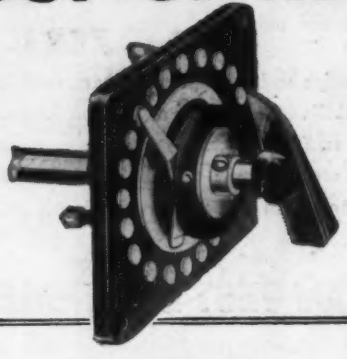


for out-of-the-ordinary



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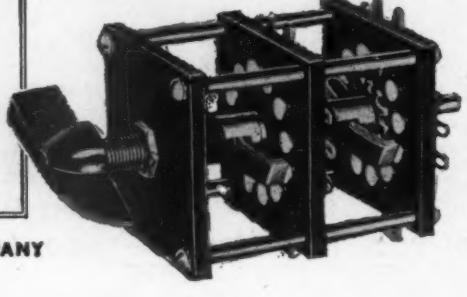


SHALLCROSS MANUFACTURING COMPANY
DEPT. E-8/ COLLINGDALE, PA.

lar types shown here, however, are likely to show advantages in cost and ready availability over special units in limited quantities.

Figures 2A and 2B are simple, basic 150-ma circuits in which the resistor unit supplies cushioning of the initial surge and acts as the sole voltage-dropping resistor. Surge voltages across the pilot light may be limited to peak values of the order of 150 percent or less of rated voltage. Figure 2C uses two pilot lights, and a low-wattage fixed resistor is shunted across the resistor unit to achieve the desired operating characteristics.

Figure 3 shows arrangements for different heater voltage require-

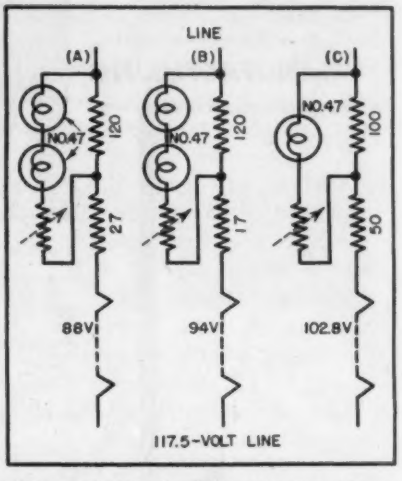


FIG. 3—Circuits for 300-ma heater stringer using type LA-701 NTC resistor units

ments with 300-ma tubes. These circuits employ the same NTC unit for the sake of standardization, the fixed resistance elements being varied to secure the desired result. It does not appear feasible to secure the total voltage drop for most 300-ma applications in the resistor unit alone, since a sufficiently large piece would have an excessively long thermal time constant.

Figure 4 shows simple and inexpensive means for automatically restoring circuit conditions upon failure of the pilot lamp, and the method is applicable regardless of the way in which the operating voltage for the lamp is secured. The resistance of the shunt protective unit is normally high compared with that of the pilot light. When the pilot fails, a substantial proportion of the total circuit voltage appears across the resistor

SYLVANIA LABORATORY EQUIPMENT

SYNCHROSCOPES

The Sylvania Synchroscope Model 5 is essentially a 5" cathode-ray oscilloscope for examining detailed structure of a portion of a periodic waveform. It incorporates a trigger generator which develops periodic pulses for synchronizing purposes. Fields of application include radar, television, pulse-time-modulation, loran, supersonics, geophysical exploration. Also available: Models 5E, P4, P4E.

THERMISTOR BRIDGES

The Sylvania Thermistor Bridge Model TBN-7SE is a radio frequency bridge providing direct reading RF power measurements. Bridge is independent of frequency; designed for continuous operation at normal laboratory ambient temperatures.

Model TBN-6SE is a radio frequency bridge providing direct reading low RF power measurements. It consists of a precision Wheatstone bridge circuit; a stabilized source of 2,000 cycle power supplying the bridge; a source of stable d-c power for substitution measurement of the RF power; and amplifier for indicating balance or degree of unbalance.

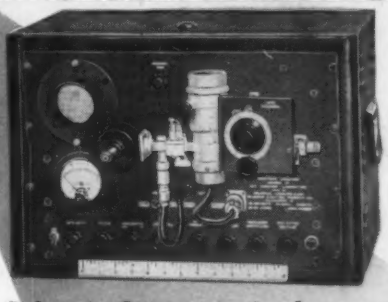
With the Model TBN-6SE, full scale meter indications from 25 microwatts to 2 milliwatts are obtainable with a high degree of accuracy.

VACUUM TUBE BRIDGE TEST EQUIPMENT

Capacitance Bridge Type 125 permits measurement of interelectrode capacitances in vacuum tubes and other multi-electrode systems. Provision is made for balancing out and measuring the direct conductance associated with the capacitance under test.

Vacuum Tube Bridge Test Set Type 129 is designed to measure the dynamic characteristics—mutual conductance, plate resistance and amplification factor—as well as the static characteristics of receiving type vacuum tubes. Several power supplies, with provision for metering them, are arranged to supply a 561-D General Radio Vacuum Tube Bridge. Operator fatigue has been minimized in this set by console-type control and meter arrangement.

SPECTRUM ANALYZERS



The Sylvania Spectrum Analyzer provides a convenient means of studying the energy spectrum of microwave generators operating as pulsed oscillators or modulated CW oscillators. Output of magnetron, klystron, rocket and similar UHF and SHF tubes can be readily investigated. Models available: TSS-4SE for 3,000 Mc region; TSX-4SE for 9,300 Mc region; TSK-2SE for 24,000 Mc region.

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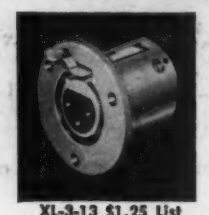

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All the features noted above on the Type "XL" with one exception (the grounding contact position) are found in other leading Cannon Connectors—the result of years of development and experience. Yet no one other Cannon fitting has all these features in a shell of so small a size. This is an outstanding value in the connector field.

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If you are a radio parts jobber and wish to cash in on the growing popularity of this line of connectors, write the factory or contact a Cannon Electric representative located in the following cities: Atlanta, Baltimore, Boston, Charlotte, N. C., Chicago, Cleveland, Dallas, Denver, Indianapolis, Kansas City, Milwaukee, Minneapolis, New Orleans, New York City, Salt Lake City, San Francisco, Seattle, Detroit, Pittsburgh, Ft. Smith, Ark., Buffalo.

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Canada & British Empire—Cannon Electric Co., Ltd., Toronto, Ontario • World Export Agents (excepting British Empire) Frazar & Hansen, 301 Clay St., San Francisco 11, Calif.

unit, followed by an extremely rapid drop in resistance to a value approximating that of the pilot. This change takes place in a matter of a few seconds before the operating temperature of the heaters has had an opporunity to change appreciably. In several applications, less than 3 percent change in total heater string voltage has been observed with the pilot light in and out of the socket. The LA-701 resistor for pilot light shunting is the same as that employed for voltage dropping and compensation in Fig. 3.

For these applications, it is inherent that the NTC units attain high final operating temperatures (around 300 F) to bring about the necessary resistance change in a suitable time interval. Moreover, the high operating temperature brings the unit to a point on the characteristic curve where the temperature coefficient is relatively low, and hence the effect of normal changes in ambient room temperature with season and geographical location on operating voltages is relatively small and unimportant.

Locating in Chassis

The high operating temperature presents no special problems to the receiver designer and it is necessary to observe only a few simple precautions in applying the units to production set design. These are: (1) The resistor unit should be suspended in air and should not be in contact with any part or component; (2) Leave the resistor leads as long as is consistent with space and mechanical support considerations,

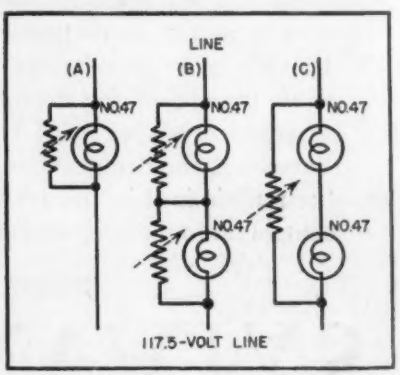


FIG. 4—Pilot lamp shunting circuits for type LA-701 units. About three percent change in total heater voltage occurs when the lamp burns out

SOMETHING NEW IN THYRATRONS

It's Federal's F-5563 . . . the tube with extra "safety valve" action for controlled high-voltage rectification

HERE'S a new mercury-vapor thyratron tube that's designed to take plenty of abuse—to function properly under temporary overloads in excess of those which can be safely handled by other tubes of this type. This is achieved by a unique grid design, which can block sudden overloads, yet still allow normal current flow through the tube.

To the user, this new longer-life tube means lower replacement costs—improved service continuity of electronic equipment through added protection.

Federal's F-5563 thyratron is backed by over 38 years of research and experience in tube design and manufacture. It has proved its ability to measure up to Federal's exacting performance standards —to pass Federal's rigid acceptance tests. And now it is ready to take its place on the industrial "firing line". Write for complete information, today. Dept. L613.

DATA FOR F-5563

MERCURY VAPOR THYRATRON

Negative-Control, Triode Type

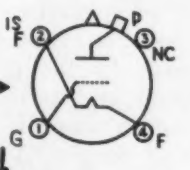
General Characteristics

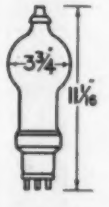
Filament Voltage	5 volts
Filament Current	10 amperes
Filament Heating Time (Minimum)	60 seconds
Typical Control Bias at Rated Voltage	—70 volts

Maximum Ratings

Anode Voltage, Peak Forward	15,000 volts
Anode Voltage, Peak Inverse	15,000 volts
Anode Current, Average	1.6 amperes
Anode Current, Peak	6.4 amperes
Temperature Range, Condensed Mercury	25°—50° C.

CONNECTIONS





DIMENSIONS

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

Federal Telephone and Radio Corporation

100 KINGSLAND ROAD, CLIFTON, NEW JERSEY

In Canada: — Federal Electric Manufacturing Company, Ltd., Montreal.
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THE BALLANTINE ELECTRONIC VOLTMETER,

DECADE AMPLIFIER

AND MULTIPLIERS

10 MICROVOLTS to 10,000 VOLTS

ONE BILLION TO ONE—This enormous range of AC voltages—is easily covered by the Model 300 Voltmeter, Model 220 Decade Amplifier and Model 402 Multipliers illustrated above. The accuracy is 2% at any point on the meter scale, over a frequency range of 10 cycles to 150 kilocycles. The Model 300 Voltmeter (AC operated) reads from .001 volt to 100 volts, the Model 220 Amplifier (battery operated) supplies accurately standardized gains of 10x and 100x and the Model 402 Multipliers extend the range of the voltmeter to 1,000 and 10,000 volts full scale.

Descriptive Bulletin No. 10 Available

BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY, U.S.A.

and anchor to large terminal lugs if there is any choice. This will result in the greatest possible temperature drop between the resistor and the supporting insulation; (3) Make sure that operating voltages are checked with the resistor unit in the proposed location after ultimate operating temperatures are reached at the room ambient conditions which are applicable. Some adjustment of operating voltages is possible by relocating the unit in a warmer or cooler position in the set.

For convenience, the resistance characteristics of the NTC units employed in the illustrated circuits are tabulated below. The rating resistance applies to a temperature of 100 F, no current. In production, tolerance is plus or minus 20% of the rating resistance. Voltage drop is measured in open air and allowance for confined space or increase due to other components must be made.

Type	*Resistance*	*Operating Current*	*Voltage Drop*
701-30	912	0.15 amp	27 v
701-15	790	0.15 amp	15 v
87-73C	2,000	0.15 amp	9.2 v
LA-701	250	0.15 amp	10 v

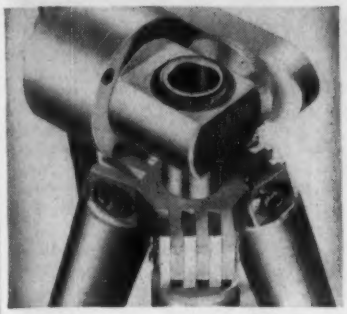
Electronic Engraving System

A PHOTOELECTRIC method of producing a half-tone screen printing plate made of plastic material has been developed by engineers of Fairchild Camera and Instrument Corp. Designed for newspaper reproduction of photographs, the finished plate compares favorably with plates made by the conventional photochemical process. The machine cannot make line cuts, such as are used in circuit diagrams, producing only 65-screen halftones.

In appearance, the Fairchild photoelectric engraver resembles a small screw-cutting lathe of reasonable precision. It is fitted with two rotating cylinders and two carriages capable of being fed at a fixed rate along the length of the cylinder. A positive photographic print, cropped or projected to the size of the engraving desired, is

Precision fastenings that cut costs— Waldes Truarc Retaining Rings!

Bowed ring gives resilient tension, ends "shimmy," costly machining!



In the Trupan Tripod manufactured by Accmatool Company of New York, a Truarc Bowed* ring positions pivot pin. It exerts a downward pressure of 50 lbs., with two-way spring action. End-play from accumulated tolerances is taken up resiliently. Tension remains constant.

Beveled ring eliminates shims, saves 20 minutes' assembly time!

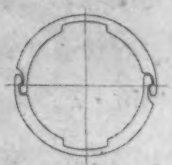
In the Tachometer Generator of Kollsman Instrument Division, Square D Company, Truarc Beveled* ring absorbs end-play rigidly from accumulated tolerances up to .010. It stays secure against heavy thrust and vibration. Ease of dis-assembly simplifies maintenance and repairs.

There's a Waldes Truarc precision-engineered ring for every fastening need. Truarc rings give a never-failing grip, keep constant circularity, do a better job of holding machine parts together. Yet they are easily removed and replaced in a few seconds. See what can be done for your product: send your drawing to Waldes Truarc Technical Service Engineers.

OTHER TRUARC RINGS GIVE BIG SAVINGS IN PRODUCTION, MATERIALS AND MAINTENANCE

CRESCENT AND E-RINGS... Snap on radially where axial assembly is impossible. Give firm grip.

SELF-LOCKING*... Economical where thrust is moderate. Shaft requires no machining. Ring holds fast.



INTERLOCKING... 2-piece ring for heavy thrusts. Positive lock against high RPMs and vibration.

INVERTED*... Uniform shoulder for abutting curved surfaces, for bearings with large corner radii.

*available for both internal and external applications

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Reg. U. S. Pat. Off.
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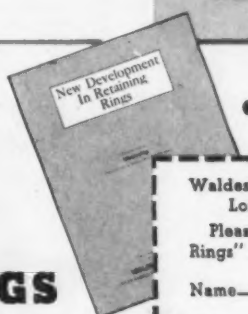

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When they couldn't get the real thing, folks turned to ersatz coffee. But they didn't like it, because any substitute is always a makeshift for something else far better and more satisfactory. Substitutes for mica are no exception. Nothing can take the place of mica wherever insulation is important. And no other mica can equal Macallen in years of experience, world-wide resources and unfailing service.

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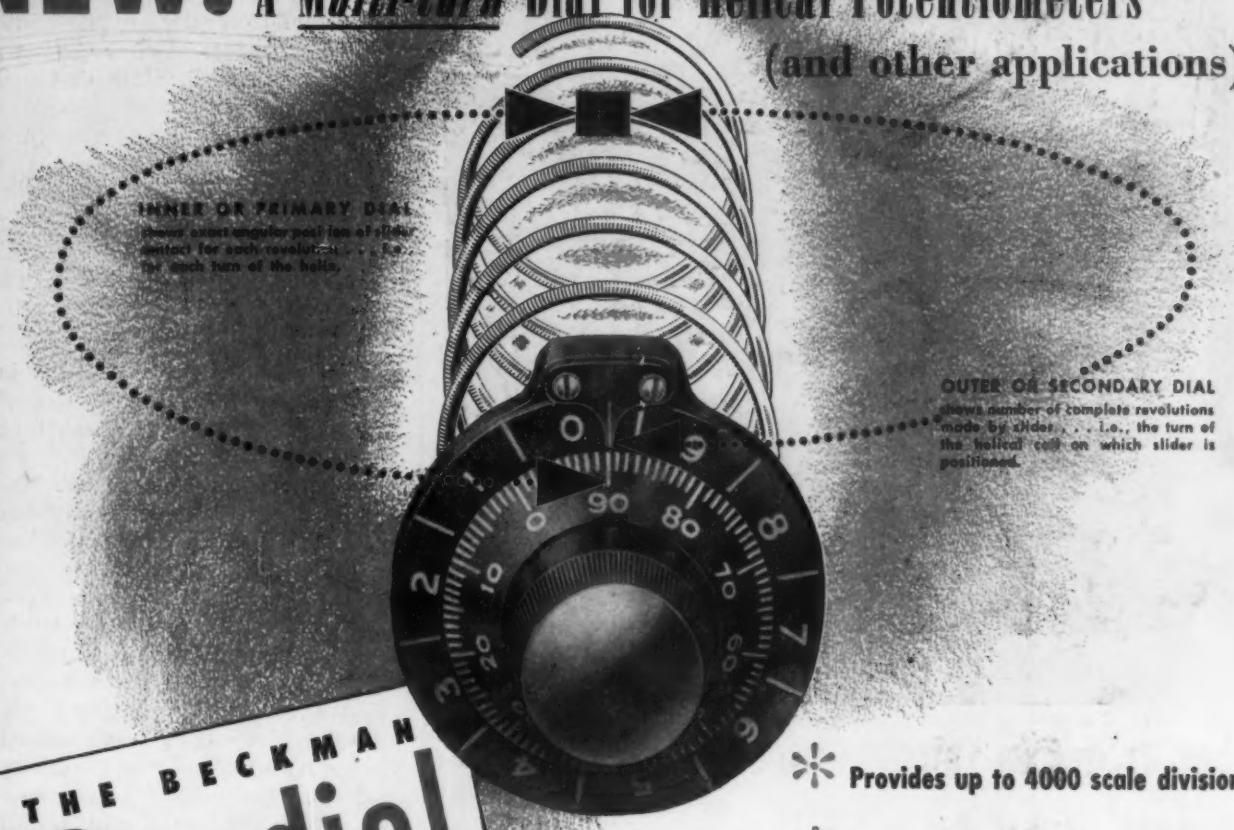
This illustration is printed from a regular copper plate engraving made by the photographic and chemical process. The original of the illustration was printed on newspaper stock and was made from a 65-screen celluloid plate formed by the Fairchild process. The man pictured is Walter Hoey who hit on the first practical basic principle making mechanical engraving possible

attached to one cylinder. There it is scanned by a photoelectric cell in a housing just above that cylinder. On the other cylinder, a sheet of celluloid or other plastic is fastened, while on the adjacent carriage is mounted the engraving cutterhead. This consists of a heated stylus, ground to a pyramid-shaped point, driven by a magnetic armature so it penetrates the surface of the celluloid, burning small pyramid-shaped depressions in the surface.

Electronic amplifiers connect the scanning system and the cutterhead so the depth of the depressions formed in the surface of the celluloid corresponds to gradations of shade of the photographic print being scanned. By tying together the frequency of the oscillation, the line advance of the cutterhead carriage, and the rpm of the cylinders, plus providing a means of backspacing one-half a dot space for each line advanced, the conventional halftone dot pattern is produced.

The completed engraving is trimmed, scrubbed in clear water, mounted on wood or metal, and is ready for use in the form. The useful area is 8 by 10 inches. An engraving of this size with a 65-line screen can be cut in 20 minutes,

NEW! A *Multi-turn* Dial for Helical Potentiometers (and other applications)


INNER OR PRIMARY DIAL
shows exact angular position of slider contact for each revolution . . . i.e., for each turn of the helix.
OUTER OR SECONDARY DIAL
shows number of complete revolutions made by slider . . . i.e., the turn of the helical coil on which slider is positioned.

THE BECKMAN Duodial

- Provides up to 4000 scale divisions
- Requires only 2" diameter space

HERE'S A DIAL development entirely new in operating simplicity, convenience and versatility. It's the Beckman DUODIAL — a multi-turn rotational-indicating unit consisting of a primary knob-dial geared to a concentric turns-indicating secondary dial, *and the entire unit so compact it requires a panel space only 2" in diameter.*

The DUODIAL permits extremely accurate vernier adjustment of driven controls and, when used with helically-wound devices such as the Beckman Helipot, it registers *both* the angular position of the slider contact on any given helix and the position of the slider along the helical winding. The DUODIAL is so designed that — as the primary dial is rotated through each complete revolution — the secondary dial moves one division on its scale.

Thus the secondary dial counts the number of complete revolutions . . . or, when used with helical potentiometers, it indicates the helical turn on which the slider contact rests.

Although developed originally for use with the well-known Helipot Potentiometer, the DUODIAL is readily adaptable to other helically-wound devices of similar nature, as well as to many conventional gear-driven controls where extra dial length is desired without wasting panel space. Its compactness and simplicity — and unique advantage of providing an accurate rotational indication from a minute fraction of a turn through as many as 40 full turns — make the DUODIAL invaluable for many applications where maximum dial accuracy is essential.

Complete information on the DUODIAL can be secured from your nearest Helipot representative . . . or write direct.

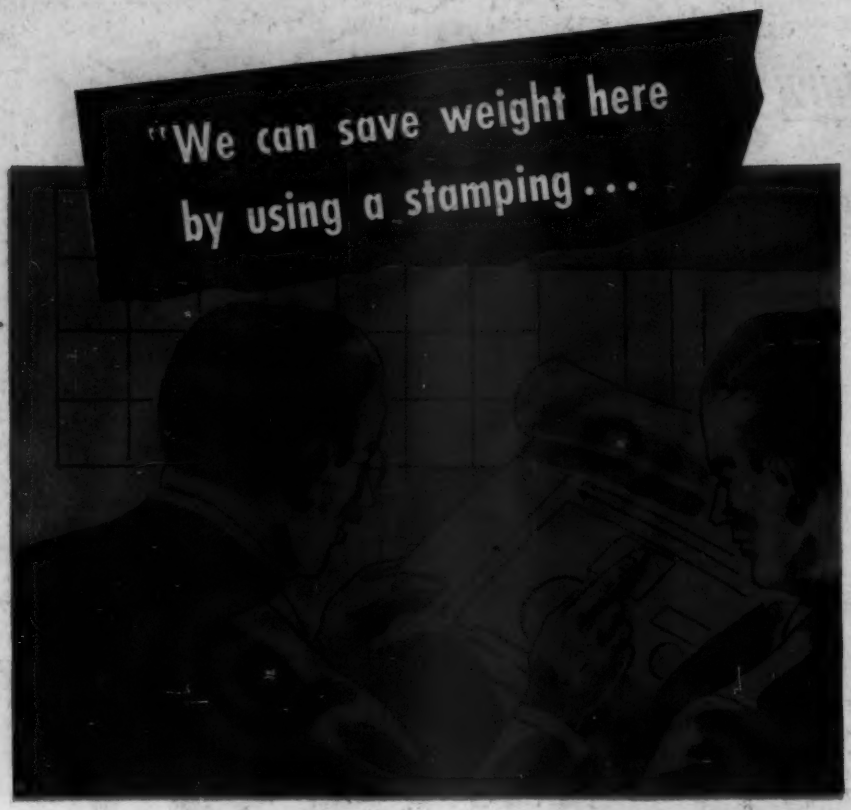
IMPORTANT DUODIAL FEATURES

- The DUODIAL contains only two moving parts. Mechanical wear and operating torque are reduced to an absolute minimum, assuring long, trouble-free life. All parts, including knob itself, are made entirely of metal for maximum strength and durability.
- The primary scale, which indicates angular position, is an integral part of the knob, and, by means of a set-screw, is rigidly affixed to the shaft of the driven device. Thus, in contrast to most turns-indicating mechanisms, the scale readings are not subject to error from backlash of internal gears. For maximum convenience in making decimal notations, this dial is graduated 0 to 100.
- The DUODIAL cannot be damaged through jamming of the driven unit, or by forcing beyond any mechanical stops. The dial can readily be used with power-driven devices, because, due to the absence of worm gears, it can be operated from either the shaft or knob end.
- The DUODIAL is currently available in turns-ratios of 10:1, 15:1, 25:1 and 40:1 (ratio between primary and secondary dials). Other ratios can be provided on special order. The 10:1 ratio DUODIAL can be readily employed with devices operating fewer than ten revolutions and is recommended for the Model C three-turn Beckman Helipot. All ratio-types are identical in size and appearance except for the numbering of the secondary (turns-indicating) dial.
- The DUODIAL is designed for mounting directly on ¼" diameter round shaft, and in all sizes the primary dial and shaft operate with a 1:1 ratio.

* Range for 40:1 ratio DUODIAL.

THE HELIPOT CORPORATION

1011 MISSION STREET, SOUTH PASADENA 2, CALIFORNIA



better get in touch with PAUL & BEEKMAN"

Are your sales suffering because your product weighs too much? Is your capacity limited because of the manufacturing process involved? Are your production expenses up because of high material costs? . . . Any or all of these problems *might* be solved by using the right metal stamping where you're now using another type of construction.

Paul and Beekman, Inc. *knows* metal stampings. We produce them in all types—from mild steel, stainless, copper, aluminum and brass, finished or plated to your requirements. We make them fast and we make them right, because we have the plant, the personnel and the organization to do just that.

If you think the use of precision stampings might enable you to put out a better product, faster, at less cost . . . call on Paul and Beekman, Inc. Write us for literature explaining our complete service.

PAUL and BEEKMAN, Inc.
1800 Courtland Street
Philadelphia, Pennsylvania
Subsidiary of PORTABLE PRODUCTS CORPORATION

since the linear travel of the carriage is 0.5 inch per minute.

Fairchild expects to get into quantity production of the engravers early in 1948, after thorough field testing which will be done in newspaper offices ranging from a weekly shop to a large plant.

Electronic Oven for Frozen Foods

AN ELECTRONIC OVEN, for use in eating places that serve hot precooked frozen meals, heats these meals in about 75 seconds to an average temperature of 160 F. Engineers in the transmitter division of General Electric Electronics Department have been eating precooked frozen meals in their experiments with the oven. Such meals have included Swiss steak with gravy, potatoes and lima beans; roast sliced lamb with gravy, potato patty and lima beans; sliced turkey with mashed sweet potatoes and peas with butter sauce; beef pot roast with peas and potato patty.

Operating in the microwave region the oven is similar to the electronic canteen which the company has produced for heating hot dogs, hamburgers and cheese sandwiches. The power required to operate the

After being unwrapped, the frozen food packets are put into a partitioned tray, inserted in the oven, and heated for about one minute. During that time, the tray revolves slowly in the microwave r-f field for uniform heating

You Need THIS BOOK!

IF high vacuum plays any part in your plans, you'll want this DPI catalog within your reach. In precise engineering terms it gives the physical, the operation, and the installation data on the latest high vacuum equipment. It covers glass pumps, metal pumps, vacuum chambers, gauges, coating units, greases and oils, and complete equipment for the high vacuum field.

This handsomely bound loose-leaf high vacuum equipment catalog will be forwarded free upon your request—and thereafter you will automatically receive new pages whenever new equipment is announced or changes made in present models. The catalog will not only bring you up to date but keep you continuously informed on all DPI developments in high vacuum equipment.

Write for your copy of

"High Vacuum Equipment" →

DP INC

Vacuum Equipment Division

DISTILLATION PRODUCTS, INC.

Rochester 13, N. Y.

"TO PRODUCE THE MOST EFFICIENT DESIGN . . ."

The engineer in the photograph above is using the G-R STROBOTAC* and STROBOLUX* to check the action of the Distributator of a Eureka Williams Corporation vacuum cleaner.

A transparent covering was placed over an opening in the front of the cleaner housing. With the STROBOTAC and the STROBOLUX the action of the Distributator bristles can be studied while the cleaner is running at normal speed. Motion can be stopped, or the cleaner can be made to appear to operate in s-l-o-w motion . . . . as slow as a fraction of an rpm if desired.

Thus the flexing of the bristles and their action as they penetrate the rug fibers can be studied . . . the wave created in the rug by the short, stiff beating bristles can be analyzed. These observations enabled Eureka Williams "to produce the most efficient design by determining the proper type of bristles, the correct length and proper spacing."

Thousands of other machine and equipment manufacturers have been able to study the operation of their products in the laboratory, on the experimental bench, and in production, with the STROBOTAC and the STROBOLUX.

Whenever motion in machinery needs to be stopped . . . whenever you wish you could see what happens in your equipment in s-l-o-w motion, think of these G-R stroboscopic devices . . . the STROBOTAC and the STROBOLUX . . . they may be of surprisingly great help to you.

WRITE FOR "EYES FOR INDUSTRY" . . . . it tells what the STROBOTAC and the STROBOLUX are, how they operate, and what they do.

In sales, too, these stroboscopes help. Here Eureka Williams Corporation use the STROBOLUX at distributor and dealer meetings to demonstrate the action of the brush on the carpet. You can s-e-e how it works.

*Reg. U. S. Pat. Off.

The Type 631-B STROBOTAC stops motion up to as fast as 100,000 rpm. In addition it is a direct-reading electrical tachometer calibrated in rpm from 600 to 14,400. Its price: $125.00.

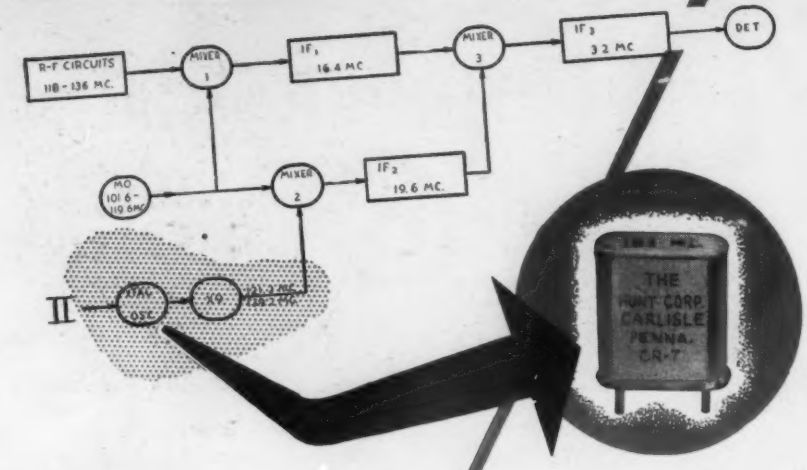
The Type 648-A STROBOLUX is an auxiliary unit used only with the STROBOTAC to increase its light output by 100 times. It is useful for photography or where exterior lighting conditions are unfavorable. Price: $205.00.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 — 920 S. Michigan Ave., Chicago 5 — 950 N. Highland Ave., Los Angeles 38

✓Chalk up another for

high stability—
close tolerance
HUNT CRYSTALS



Here's the problem: "The frequency shall not deviate more than 0.003% from the nominal frequency over the specified temperature range. This tolerance is inclusive of the calibration error allowed." These were the specifications given by Collins Radio Company, Cedar Rapids, Iowa.

Here's the solution: This specially developed CR-7—high stability, close tolerance Hunt Crystal Unit—operating over a temperature range of −30° Centigrade to +70° Centigrade covering a band from 13.466666MC to 15.466666MC on fundamental operation.

COLLINS RADIO COMPANY developed the 51M-series, VHF ground station receivers. Illustrated above is the Drift Cancelled Oscillator Circuit, exclusive with Collins, employed with these receivers.

To assure the remarkable stability of this receiver an exceptionally stable crystal was essential... Collins turned to The Hunt Corporation—maker of high stability, close tolerance, precision crystals.

You, too, can get better results for a longer time by building your circuit around Hunt Crystals. Let our engineers and crystal technicians help you with your set... call us today.

THE Hunt CORPORATION
CARLISLE, PA.

Pacemaker in Stability

new unit is the same as that used for a domestic electric range.

In appearance, the complete unit resembles a small domestic refrigerator. Meals are passed to the oven through a small aluminum door near the top.

As shown in the photo, an on-off switch and a small indicator lamp to show if the oven is ready to operate are located at the upper left. A timer-dial and another indicator lamp to show if the high-frequency radio power is on are at the upper right. The timer-dial can be set to provide the required heating period.

After the unit has been turned on for the day's operation, the operator places the precooked food in the heating cavity near the top of cabinet and closes the door by stepping on a bar near the bottom of the unit. The high-frequency power goes on automatically and later is turned off by the timer. When the power shuts off, the door opens automatically, and the meal is ready to eat.

The electronic oven is being operated in tests at Maxson Food Systems, Inc. of New York City, and until field tests have been completed it is not planned to produce the equipment in large quantities.

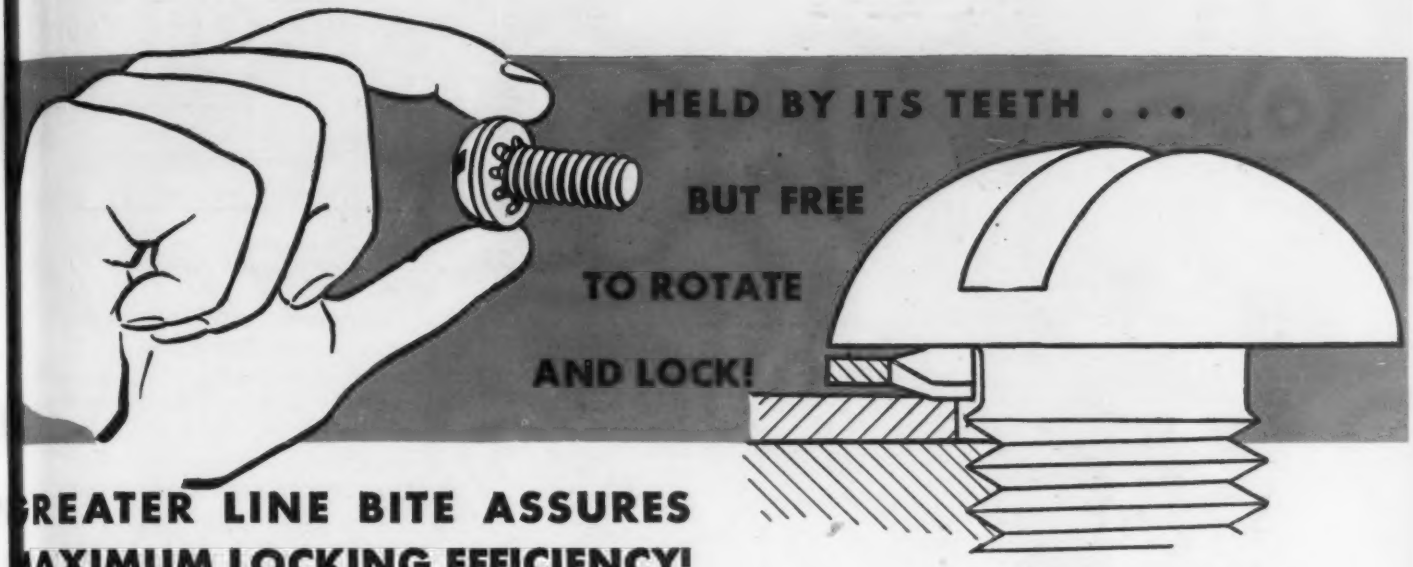
Q-Meter Control for Power Losses

IN THE high frequencies, electron tubes display power losses which vary from tube to tube even though all the conventional electrical characteristics accurately represent their correct nominal values. Such losses can often be traced to minute deposits of metallic oxides on the insides of the glass blanks and Eitel-McCullough, Inc. has established routine tests for detecting tubes bearing the power dissipating deposits.

As shown in the accompanying illustration, tubes to be examined are snapped into a suitable fixture which shorts together all elements except the anode for one side of the circuit and connects to the anode for the other. Thus the meter is measuring Q directly across the glass blank. A conventional Q meter is utilized and production limits are established empirically

WHERE INTERNAL LOCK WASHERS ARE REQUIRED, SPECIFY

SEMS *by* SHAKEPROOF

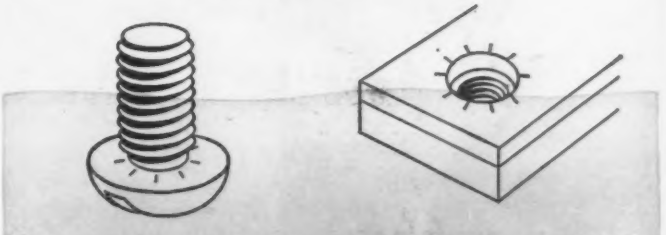


GREATER LINE BITE ASSURES MAXIMUM LOCKING EFFICIENCY!

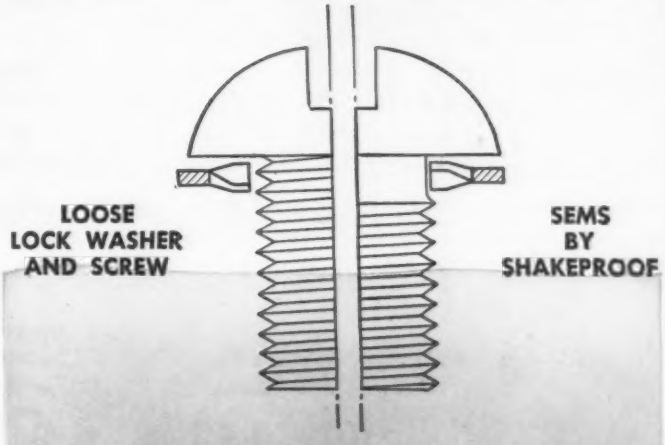
addition to the important cost savings secured with pre-assembled shers and screws and the well known features of Shakeproof lock shers, sems by Shakeproof provide other special advantages ich assure better fastening results. By making the internal diam- r of the internal type toothed washer smaller than the diameter the screw thread the lock washer is held on the screw by its teeth t is free to rotate and lock. When separate washers and screws e used, the washer has to have an internal diameter larger than e diameter of the screw thread. This means that the teeth of the ernal type lock washer on a sems by Shakeproof are longer for e same overall washer diameter and thus have greater contact th the clamping surface of the screw head and consequently creased locking power.

so, because the lock washer is held on the screw so that it is free rotate, the line-bite of each locking tooth is utilized to its full iciency. As the screw is driven home the teeth are positioned con- ntric with the screw. There is no opportunity for canting or buckling d thus full locking action starts at the instant of contact.

ecify this efficient, cost-saving fastener unit — write for complete gineering data on sems by Shakeproof!



These illustrations of screw and work piece show the line-bite of the lock washer teeth. The washer has been cut away from the screw to show how the bite marks closely approach the unthreaded portion of the screw shank proving greater locking contact. Also, note absence of any trace of milling action.



This combination cross section view shows a comparison between sems by Shakeproof and a washer put on a screw after the thread is rolled. Note the smaller internal diameter of the lock washer on the sems with the thread holding the lock washer on the screw by its teeth. Also, observe how maximum tooth engagement with minimum overall washer diameter is assured.

SHAKEPROOF inc.
fastening Headquarters

Division of ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
Offices in Principal Cities
Plants at Chicago and Elgin, Illinois
In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

NEW
TECH-LAB DEVELOPMENT

For RAPID MEASUREMENT OF AUDIO FREQUENCY GAIN or LOSS

TYPE 1A
TRANSMISSION
MEASURING SET

Completely Self-Contained
PORTABLE ● AC OPERATED

With this instrument it is possible to quickly and accurately analyze and service equipment in different locations without fuss in time consuming demounting and transportation of apparatus. It will thus pay for itself in a short time and no modern radio station can afford to be without it. It can also be used to good advantage in factory checking and inspection of audio equipment.

The set combines in a modern efficient manner an accurate vacuum tube voltmeter, an audio oscillator with four fixed frequencies and a precision attenuator all mounted in a handy cabinet easily carried by the operator.

SPECIFICATIONS

- GAIN: Up to 80 db.
- LOSS: 60 db. maximum.
- VACUUM TUBE VOLTMETER: Range—40 to +40 db. (1 mv. ref. level)
- AUDIO OSCILLATOR: Freq. Range; 100 to 10,000.
- PRECISION ATTENUATOR: Flat to 20 KC; 93 db. in 3 db. steps.
- DIMENSIONS: 10¼" x 16¼" x 8¾"
- WEIGHT: 30 lbs.
- INPUT: 115 Volts. 60 cycles, 70 watts.

TECH LABORATORIES, INC.
Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

Type 4-125A Eimac tetrode is subjected to production test for loss-creating metallic-oxide deposit inside envelope. Standard Q meter has provision for attachment of series of fixtures for various tube types

by determination of power-output decrease. Different tube types, therefore, exhibit different readings. Measurements are made at approximately 55 megacycles.

Extending Frequency Range Of Pen-Type Recorders

by H. S. HEMSTREET
Research Engineering Department
Firestone Tire and Rubber Co.
Akron, Ohio

and R. G. HILL
Test Engineer
Electronics Laboratory
The Glenn L. Martin Company
Baltimore, Md.

PEN RECORDERS in general use may be classified broadly as a-c and d-c types, depending on the kind of signal applied to the penmotor. Those that respond to d-c signals have the disadvantage of zero drift common to nearly all systems using d-c amplifiers and poor frequency and transient responses. Within these limits, varying d-c voltages and currents may be recorded. The amplitudes of a-c voltages and currents may also be recorded if rectified to produce d-c signals to which the recorder will respond. Additional inaccuracies are introduced, however, in the time delay and averaging characteristics of the rectifier.

These difficulties can be avoided by using the type of recorder which responds directly to a-c signals. Since the actual a-c voltage is recorded, there is no zero-drift prob-

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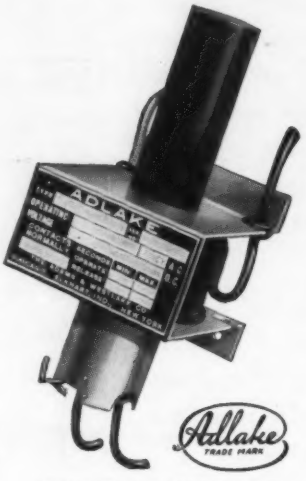

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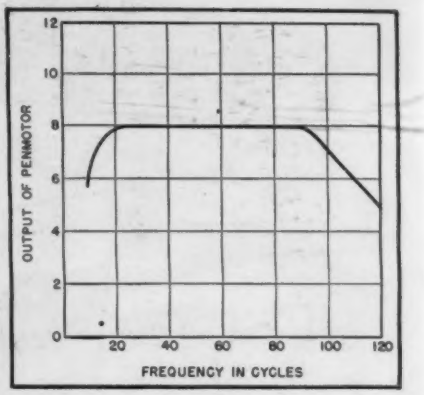

FIG. 1—Response of pen recorder with constant input voltage

lem. In addition to this increased long time accuracy, the frequency and transient responses of a-c amplifiers can be made superior to that of d-c amplifiers. The dynamic friction of the a-c penmotor is less than the static friction encountered with d-c systems.

Penmotors responding to a-c signals have a limited frequency response which nullifies their advantages when used for frequencies higher than about 120 cycles (see Fig. 1). This difficulty can be surmounted by converting the signal to a lower frequency which falls well within the upper limit to which the penmotor can respond. This conversion can be accomplished by beating the signal against a reference signal and this method was used to record 400-cycle voltages which were amplitude modulated at 0 to 30 cycles.

A block diagram of the final converter is shown in Fig. 2. The 400-cycle signal is fed in series with the reference, 460 cycles, to a diode mixer. The beat of 60 cycles together with the undesired fre-

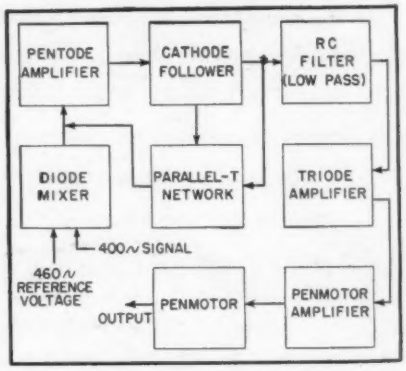

FIG. 2—Block diagram of the converter system for extending the frequency range of a pen recorder

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THE WELL BALANCED DESIGN of conductors and dielectric in Anaconda Type ATV lead-in lines fulfills the exacting requirements of wide-band reception. For FM and television reception, these lead-in lines minimize the effects of attenuation and impedance mismatch—providing maximum freedom from distortion.

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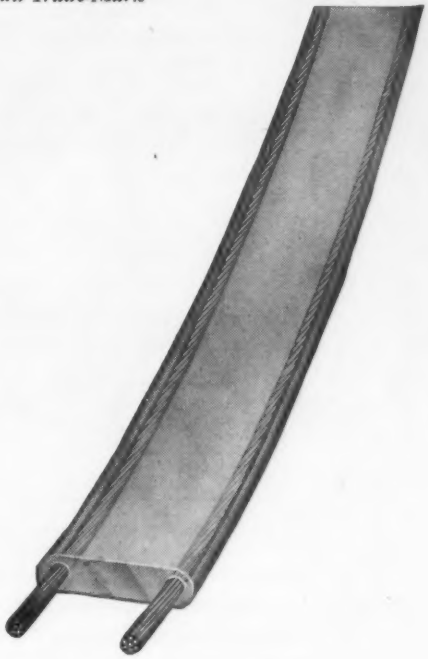

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quencies is fed to a high-gain pentode amplifier and from there to a cathode follower. A parallel-T network, driven by the cathode follower, provides a frequency-sensitive negative feedback path to the input of the pentode amplifier. Since the parallel-T is essentially a band rejection filter, using it in a feedback network causes the associated amplifier to have a gain characteristic which is a maximum at the tuned frequency of the parallel-T.

A parallel-T, tuned to reject 60 cycles without the RC filter was first tried. It was found that if the parallel-T was made sufficiently sharp to reject the 400-cycle components, the desired flat bandpass for 60, ± 30 cycles, was lost. If, on the other hand, the flat bandpass was obtained, the attentuation at 400 cycles was not sufficient. Therefore, the parallel-T and low pass RC filter combination was selected. The resonant frequency of the parallel-T was increased so that the attenuation characteristics would be essentially the opposite of the RC filter characteristic in the region where a flat bandpass was desired. This is illustrated in Fig. 3.

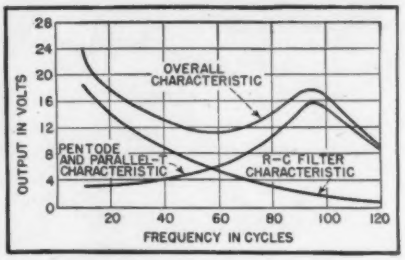
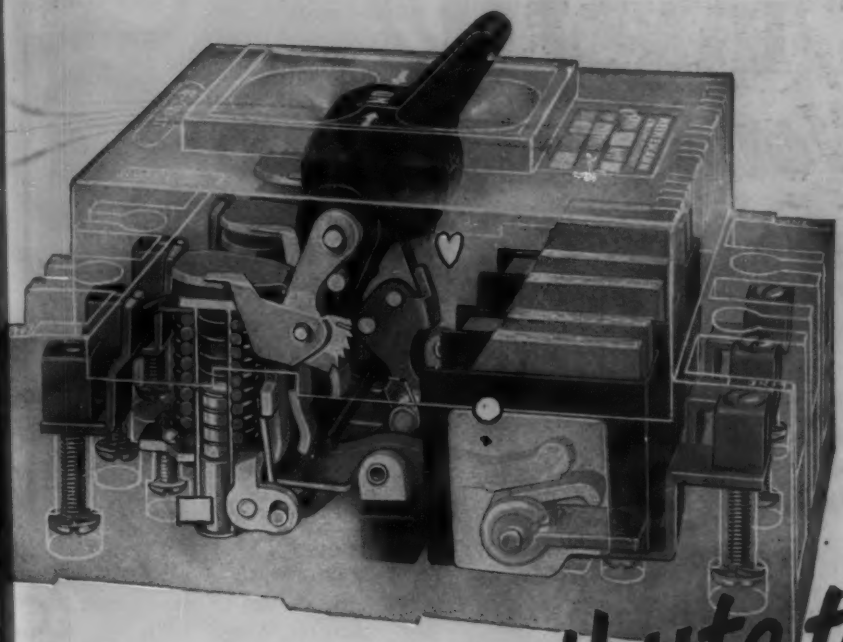
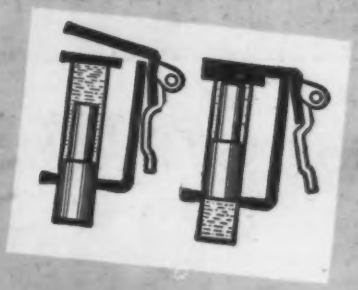


FIG. 3—Overall response of the converter

The parallel-T is such that at 95 cycles a minimum of negative feedback is applied to the pentode. As the frequency departs from 95 cycles, the amount of negative feedback increases. Thus the pentode amplifier, cathode follower, and parallel-T network function to produce a pass characteristic which has maximum gain at 95 cycles and decreasing gain for higher or lower frequencies. The output of the cathode follower is fed to the low-pass RC filter. This filter, operating in conjunction with the preceding stages, gives an overall pass band which is relatively flat from 30 to 90 cycles.

The output of the RC filter is fed





TIME DELAY ON OVERLOADS

The magnet coil surrounds a hermetically sealed liquid filled cylinder containing an iron plunger which while normally out of the magnetic field moves into it on overloads, the liquid controlling its speed. As the plunger rises to the top of the cylinder, the magnetic flux increases to its maximum. At this point the armature is attracted and operates the latch.

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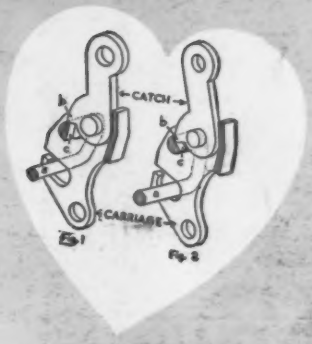

HIGH SPEED LATCH

The armature, on engaging the lower leg of the lock (a) rotates it so that the tooth of the catch (b) passes through the cut portion of the lock (c) and opens the contacts. Of all known latches this one acts with the least amount of friction and mechanical delay. The latch collapses only on short circuit or overload conditions even if the handle is purposely held in the "on" position.

They employ an overload trip unit that is FULLY ELECTRO-MAGNETIC and have definite and instantaneous trip points independent of their time delay characteristics. The current carrying capacity as well as the minimum and instantaneous trip points are not affected by ambient temperatures. A true inverse time delay in the hermetically sealed unit allows the passage of inrush current. However, continued overload opens the breaker in time inverse to the ratio of the current.

HIGH SPEED BLOWOUT

The stationary contact is coiled around an insulated iron core connecting steel plates to form a U-shaped magnet. On overloads and short circuits, the current flowing through the contact creates magnetic lines which force the arc into the arcing chamber and blow it out. As the value of the current to be interrupted increases, the quenching effect becomes greater due to intensified magnetic field.

HEINEMANN ELECTRIC COMPANY

Established 1888

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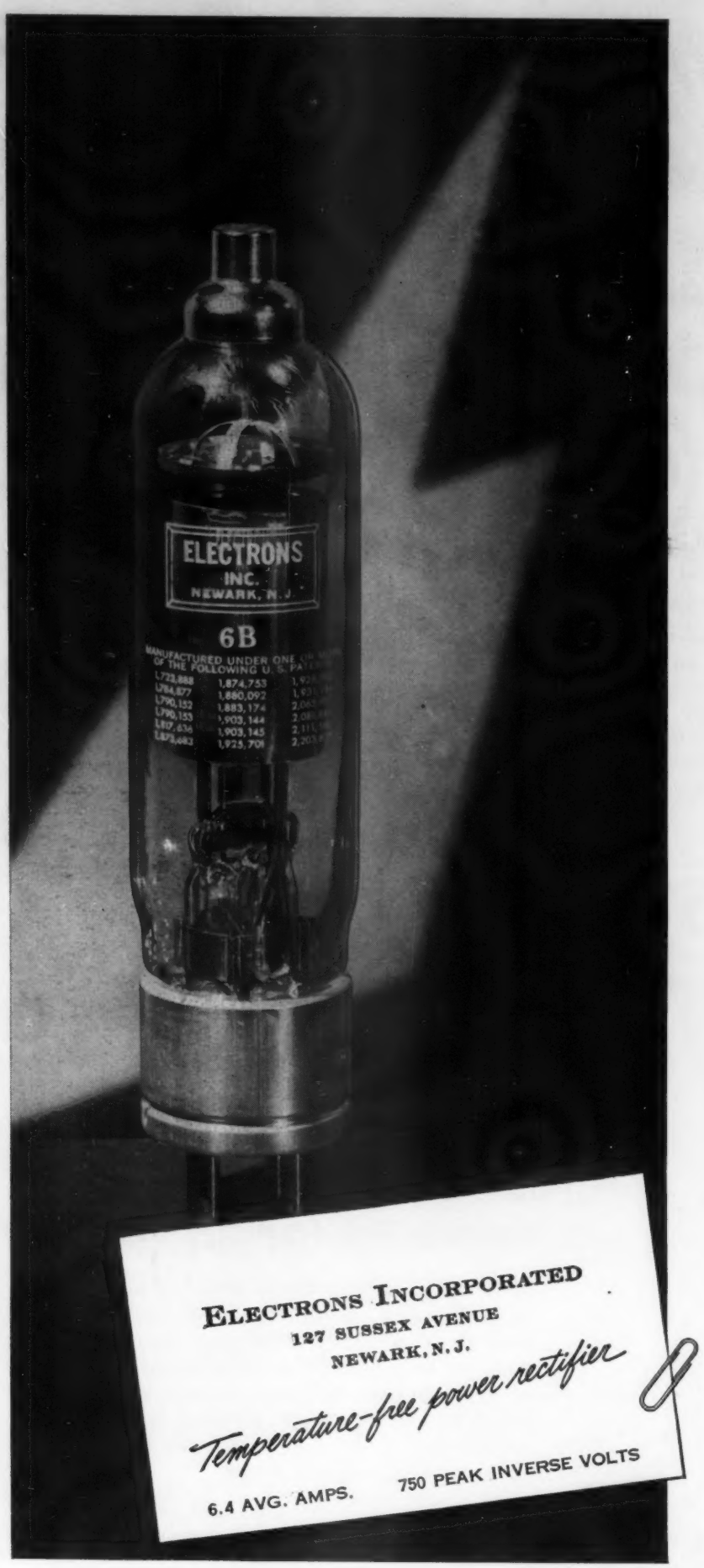


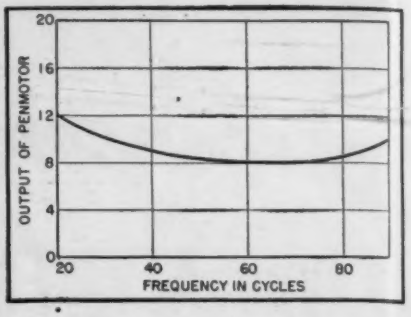


FIG. 4—Response of converter and penmotor with the input voltage held constant

to a triode amplifier to bring the signal to a more convenient level. This signal feeds the penmotor amplifier, which in turn drives the penmotor, making the recordings.

The overall characteristic of the converter, penmotor amplifier, and penmotor is shown in Fig. 4. Amplitude modulation up to 20 cycles (about the 60-cycle carrier), and the resultant sidebands, are very faithfully recorded. Sidebands up to 30 cycles removed from the carrier frequency are recorded with sufficient accuracy for all but the most precise laboratory work. Actually the overall response as shown in Fig. 4 could be made still more flat by a second, suitably designed, parallel-T feedback loop. Sidebands up to 30 cycles or more could then be recorded with an extremely small amount of distortion. In the application for which the converter was originally designed the pass band of Fig. 4 provided sufficient fidelity, so the second feedback loop was not used.

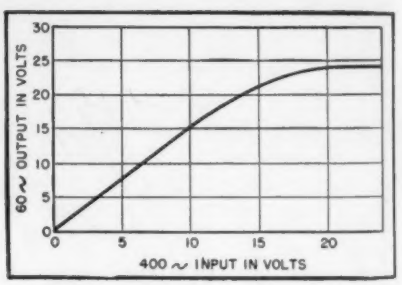
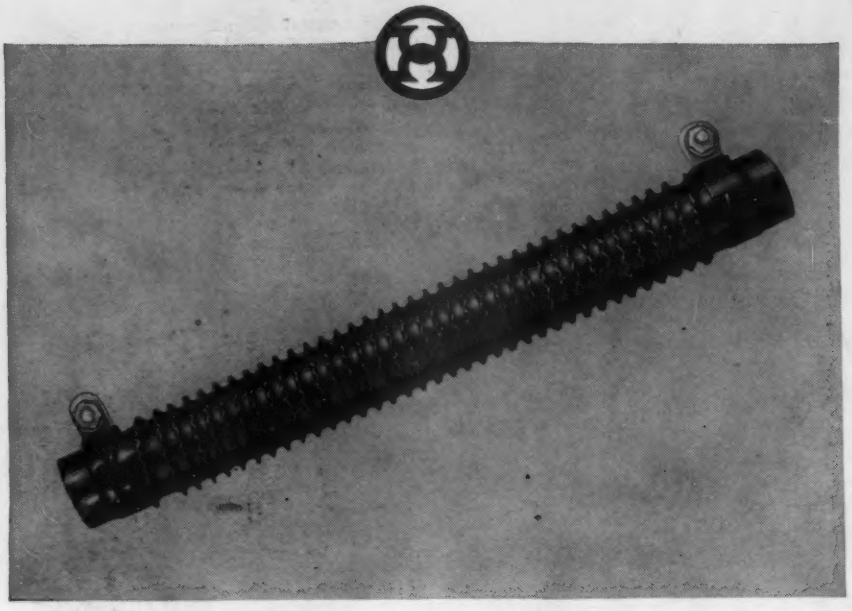


FIG. 5—Linear relation between 400-cycle input and 60-cycle input

The linear relation between the 400-cycle input voltage and the 60-cycle output voltage from the converter is shown in Fig. 5. When applying the 400-cycle voltage as a step function, the 60-cycle response is identical to the record obtained when a 60-cycle step func-

HARDWICK, HINDLE
Crinkle Wound
Resistor



OUR CRINKLE WOUND resistors are designed especially for relatively low value of resistance with a high current carrying capacity.

They fall within the classification of bare resistors by NEMA and Underwriters' regulations, permitting operation at a temperature rise of 350 degrees C.

The ribbon of resistance alloy is wound on edge upon the refractory tube—the ends braised to heavy copper terminals. A vitreous enamel covering anchors the turns securely and prevents move ment. *The result is an unusually large area for heat dissipation.*

Units with intermediate taps are available. There are 5 sizes: 155 to 420 watts, from .125 to 20.0 ohms.

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tion is applied directly to the penmotor amplifier.

This converter may very conveniently be used for any audio frequency by merely changing the reference to maintain a 60-cycle difference from the signal.

Complete freedom from pickup is afforded by electrostatic shielding alone. The commercial pen recorder used was Brush model BL 202; the penmotor amplifier was Brush model BL 905.

Tubes Find Iron in Ore

From McGraw-Hill World News

AN ELECTRONIC detector which scans broken ore on conveyor belts for tramp iron and trips the belt automatically, preventing damage to crushing mills, has been developed by Aberfoyle, Tin, N. L., at its Rossarden, Tasmania, mine. The problem was to devise a detector that would not respond to wolfram and other wildly magnetic ore.

The ore is made to traverse a magnetic flux under an electromagnet which induces poles in the core limbs of a detector magnet under the belt. As long as ore passes, no disturbance of the magnetic flux lines takes place, and no electromagnetic force is induced in the detector magnet coils. But a piece of iron, passing on the belt, upsets the magnetic field and induces a small electromagnetic force in the magnet coils.

This is impressed across a grid and cathode of a vacuum tube in a three-stage amplifier, successively amplified, and finally fed into the relay circuit controlling the conveyor and ore feeder motors.

The detector operates on a 18-inch conveyor belt carrying ore at a speed of 200 feet per minute. To prevent too frequent tripping of the motors, a small tramp iron magnet first picks out all easily removable tramp iron, leaving the electronic detector to act on deeply buried metal pieces. It is sensitive enough to react on 0.75-inch iron nuts.

THERE IS ENOUGH magnesium for four million Flying Fortresses in every cubic mile of sea water.

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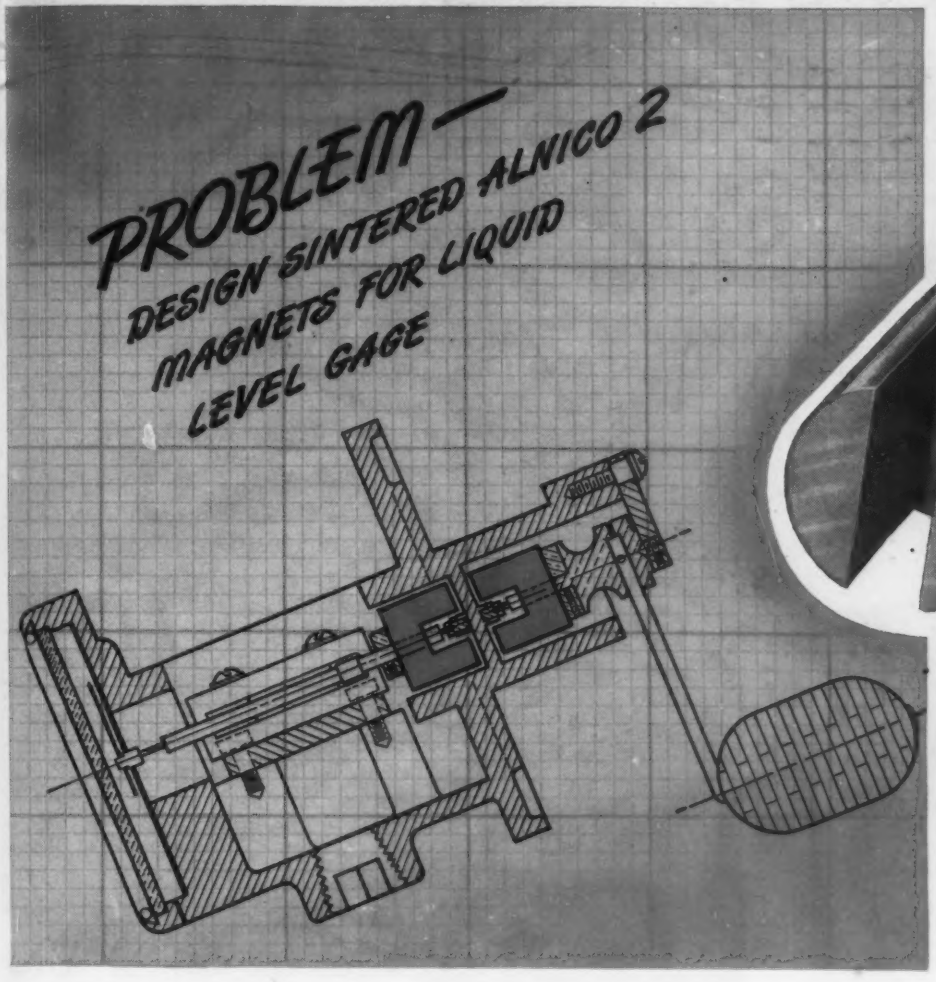
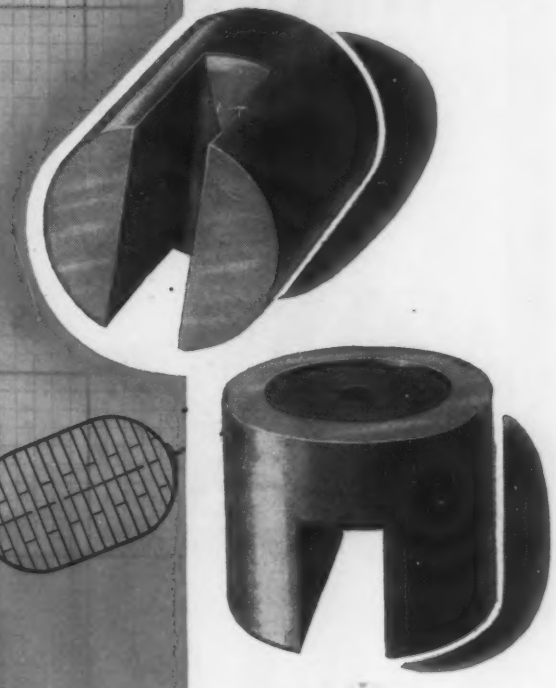
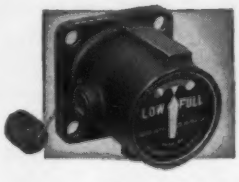


Here's another outstanding application for one of the many G-E permanent magnet materials —the magnetic liquid level gage manufactured by The Boston Auto Gage Company.



The Magnets that Guard your Transformer



Two G-E sintered ALNICO permanent magnets, separated by an aluminum diaphragm, function as a leakproof magnetic coupling in this gage to accurately indicate the level of the insulating liquid in transformers. The rise or fall of the float actuates the dial pointer by means of the coupling.

In addition to the large group of sintered and cast ALNICO permanent magnets, General Electric now offers you greater flexibility of magnet design with the ductile alloys CUNICO, CUNIFE and SILMANAL and the lightweight, non-metallic VECTOLITE. Be assured of receiving magnets of the highest uniform quality resulting from precise G-E production methods, accurate testing and rigid inspection.

Let us help you with your magnet application problems. General Electric engineers, backed by years of research and magnet design experience, are at your service. *Metallurgy Division, Chemical Dept., General Electric Co., Pittsfield, Mass.*

SEND FOR our new bulletin, CDM-1, "G-E Permanent Magnets", specifically designed to help you with your permanent magnet problems.
This bulletin contains information about the characteristics and properties of G-E permanent magnet materials, their application and design.

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ELECTRON ART
(continued from p 138)

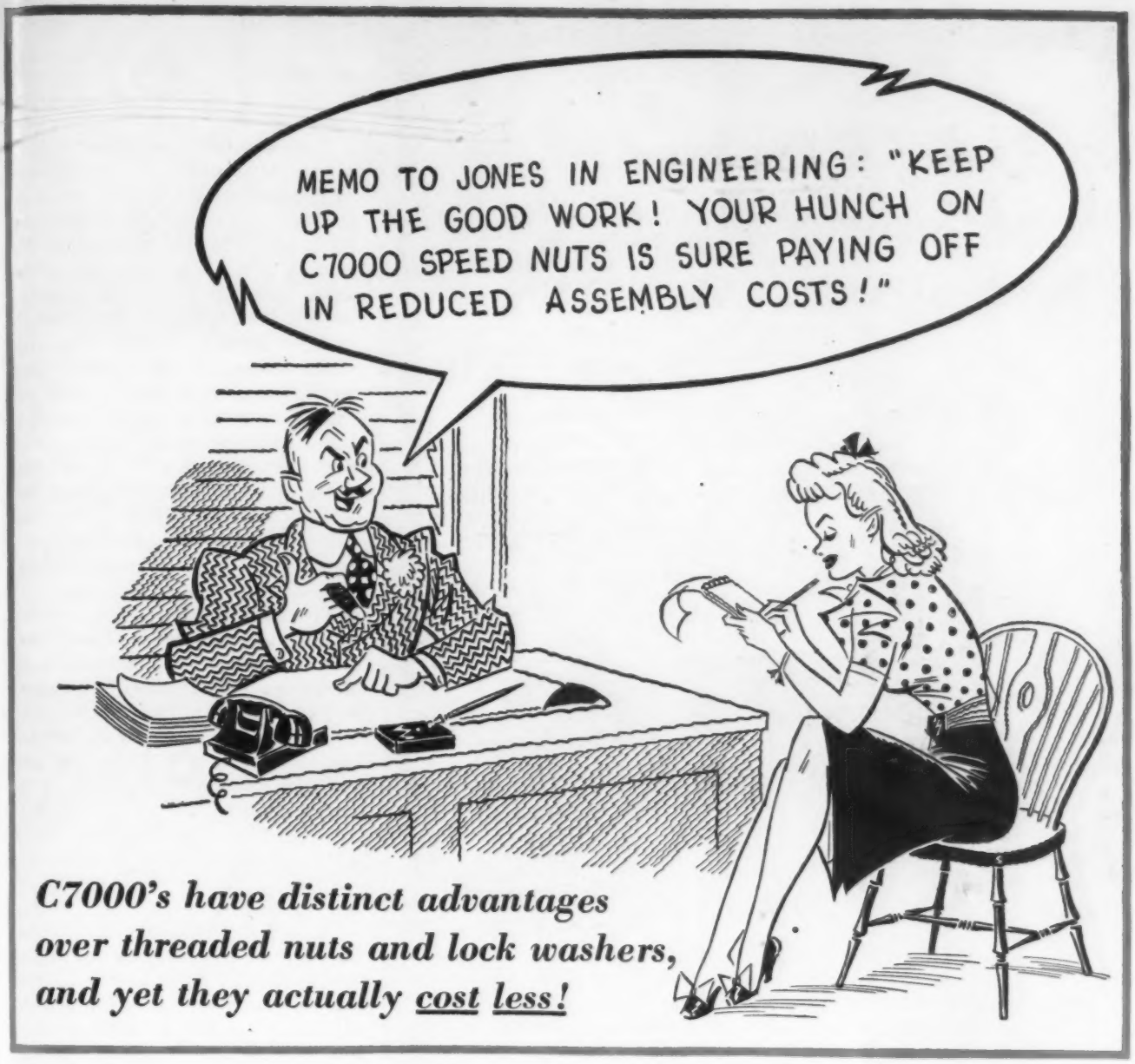
vantage is its freedom from noise on long circuits requiring many repeaters.

Operating Batteries at Low Temperatures

INVESTIGATIONS into the functioning of small dry batteries at temperatures between + 50 and − 60 C by J. P. Schrodt, D. N. Craig, and G. W. Vinal of the National Bureau of Standards indicate that satisfactory operation can be obtained at low temperatures by using an alternating heating current. If the battery is to be kept constantly in service, it can be heated by a small alternating current. Should the battery be used only intermittently, it can be brought to operating temperature quickly by a larger alternating current. Discharge of the battery through the heating circuit can be prevented either by interposing a capacitor, a counter emf, or by bucking the two halves of the battery against each other in the heating circuit (PB 50853).

Infrasonic Switching

READERS have commented on the article about infrasonic switching that was published in these columns (p 214 March 1946). Briefly the article by Angelo Montani reported experiments from which it was found that if continuous sounds were chopped into time sequences lasting 0.033 seconds and separated by 0.033 seconds of silence, the sounds were still perceived as continuous. Physiologically the phenomena was explained on the basis that the sound must exist for sufficient time to establish the sensation of pitch, but that sufficiently short interruptions cannot be perceived. The 0.033 period is long enough to establish a sensation of pitch for frequencies between about 200 and 10,000 cycles per second, but not long enough for the interruptions to be noticeable, being the period of a 15 cps wave, which lies below the normal audible limit. The phenomena could be applied to communication by switching two channels alternately onto one carrier either for dual channel operation or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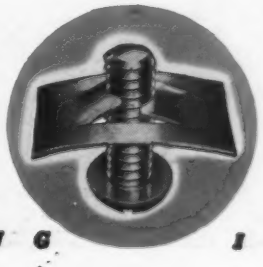

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We maintain that the future of the plastics industry rests on applications such as these, and not on the Sunday-supplement or pipe-dream kind of application that helps neither user nor moulder —the kind developed by wartime shortages or over-enthusiasm.

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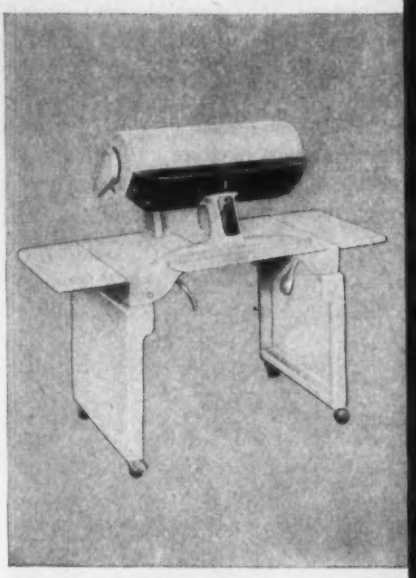
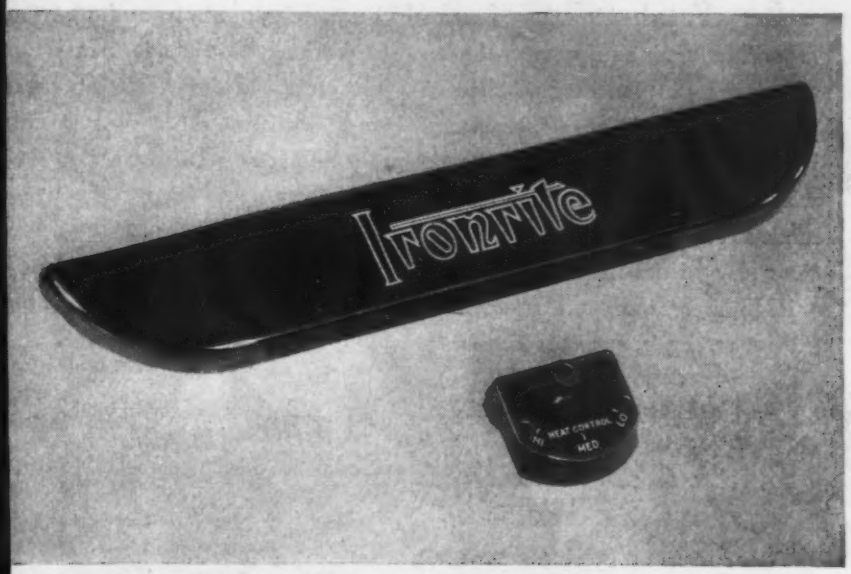
On this outstandingly successful ironer with its proven ability to iron even such intricate items as shirts, plastics take a large share of the credit. The heat-resistant phenolic feedboard pre-warms and smoothes out the clothing as it is fed into the ironer. It is comfortable to the touch because, unlike metal, it has limited heat conduction. Kurz-Kasch engineers helped plan this feedboard, as well as the thermostat control housing, 11 years ago. ***Both moulds are still in use after repaying their costs many times.***





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The entire transmission line system was supplied by Andrew Co. and installed by WELD with the assistance of skilled Andrew Engineers.

The Andrew reputation for supplying quality components, and for engineering skill, already is well established in the FM field. Call on Andrew for assistance in solving *your* FM problems!

ANDREW FM-AM isolation section with cover removed, revealing two 3⅛" FM transmission lines and expansion joints.

ANDREW CO. EQUIPMENT AT WELD

- Duplicate 3⅛" FM transmission lines, expansion joints, elbows, tower brackets, and all fittings.
- Horizontal "bazooka" sections for isolating WELD (FM) from WBNS (AM).
- Auxiliary antenna for standby service.
- Assistance to WELD personnel in installation of transmission line and "bazooka."

ANDREW CO.

363 EAST 75th STREET · CHICAGO 19

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WRITE FOR COMPLETE CATALOG

Pioneer Specialists in the Manufacture of a Complete Line of Antenna Equipment

for two-way communication over one carrier.

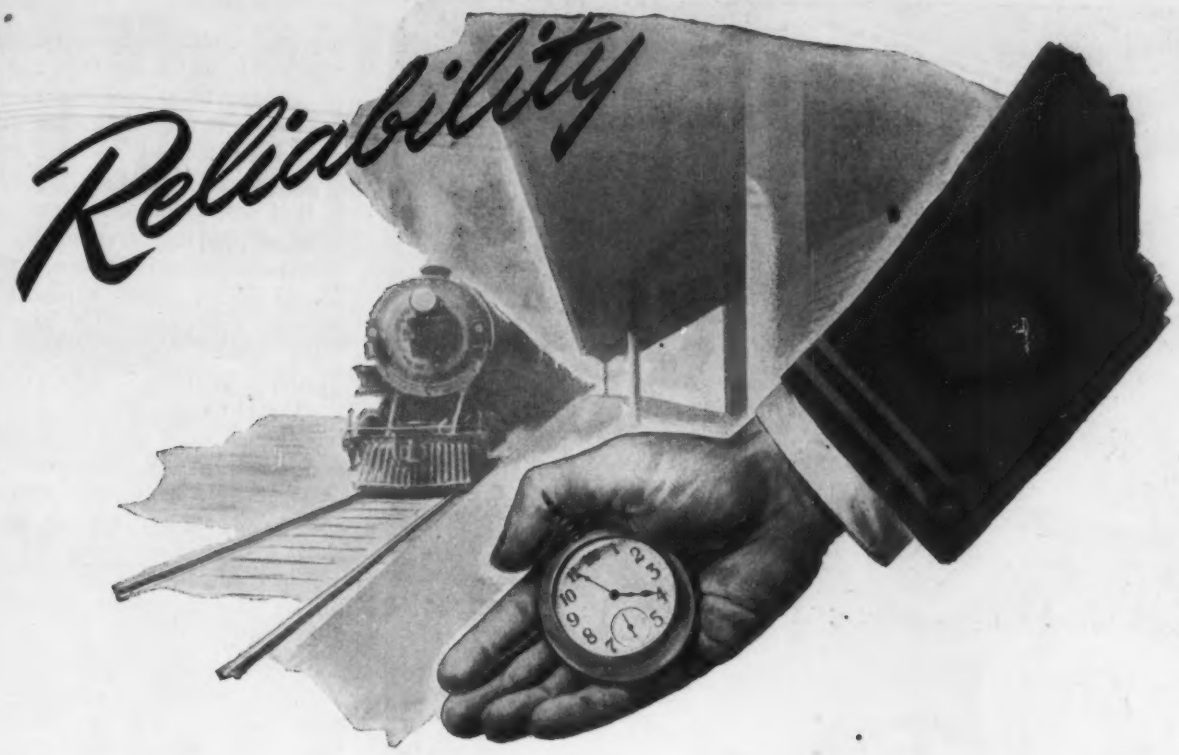
Readers Reply

Several readers expressed doubts about the existence of a persistence of hearing. In the hope of reconciling the conflicting interpretations, an experiment was planned to duplicate Dr. Montani's measurements. However, it was impossible with the laboratory facilities available to arrange a sound source (loudspeaker or earphone) that would abruptly switch on and off (as observed under stroboscopic light). Furthermore it became evident from observing the sound from a monitoring microphone that the experiments would have to be conducted in a completely sound absorbing room to avoid reverberation. It was also evident that, to adequately interpret the results, some study and search of collateral literature would be necessary to determine how much of the apparent persistence of hearing was due to hangover of the eardrum and associated mechanical elements of the ear and how much was due to response-relaxation time of the aural nerves. These considerations are reviewed here to indicate what factors need further experimental investigation.

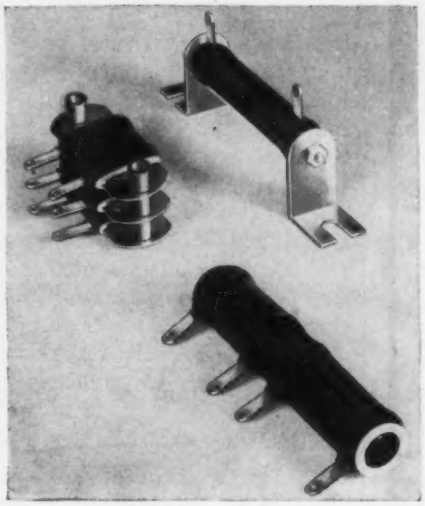
Readers pointed out other difficulties. The substance of their comments and those of the author, whom we invited to elaborate on his short original note, appear below.

"Some time ago I experimented . . . with both squarewaves and sinewaves from the infrasonic to the ultrasonic . . . until I was blue in the face. The results in the infrasonic range were uniformly intolerable. The ear is not easy to fool . . . perhaps the nine-foot tube that Dr. Montani used in his experiment accounts for his results. My earlier experiments, performed with the same applications in view, proved to my satisfaction that it is not possible to chop up sound at any audible or subaudible frequency without introducing intolerable distortion.

"My experiment consisted of fixing a semicircle of copper to the wheel of a hand-operated grinder, arranging a spring contact to bear on it (forming a crude commutator)



A Feature of I-T-E Power Wire Wound Resistors



Ratings of resistors range from 2 to 215 watts in fixed and adjustable types and from 30 to 75 watts in oval types.

I-T-E Resistors are reliable because of their inherent quality—in design, materials and construction. The purest resistance wires obtainable are uniformly wound on a ceramic tube, tied to terminals and silver soldered for a permanent positive connection. Then the resistor is locked and sealed with a coating of baked enamel. This blue black vitreous enamel produces a moisture repellent surface with high heat dissipation.

I-T-E Resistors are made fixed or adjustable, standard or special. These resistors are constructed to very close tolerances to meet critical conditions of atmosphere and usage. They are available in a number of sizes, types and ratings to meet almost any requirements. Different types of terminals are also available to meet various applications.

Complete information on I-T-E Power Wire Wound Resistors, their uses and applications, derating and size selection, together with photographs of each type and tables of values, is contained in the Resistor Catalog. Write today for your copy.

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and connecting the terminals across the voicecoil of a radio loudspeaker. By turning the crank I was able to modulate the radio program at a variable low frequency. What happened to voices shouldn't happen to a dog. I have since confirmed this result using electronic modulation. Switching of speech at any low frequency gave abnormal results, the sounds being completely unintelligible. At higher frequencies (100-1,000 cps) voices could be understood; at higher frequencies the modulation frequency is annoying. I have since confined my efforts in this line to the ultrasonic region where the technique is theoretically possible but where the practical difficulties are considerable." (signed) John R. Cooney, Waldoboro, Maine, March 4, 1946.

"Before making any statement about a persistence of aural image, a more carefully considered experiment than that reported by the author would be necessary. For example, consider the results obtained. At 1,000 cps the minimum duration necessary for the tone to generate the physiological sensation of pitch was found by him to be 0.012 second. There is then a 1,000 cps wave for 0.012 seconds followed by a pause of 0.012 second, these pulses of tone and silence repeating themselves as a regular sequence. If the sequence is expanded as a Fourier series, the terms will be of the form

$$\mathrm{Sin}2\pi\ 1{,}000\left[\frac{1}{2}+\frac{2}{\pi}\left(\sin 2\pi 42t+\frac{1}{3}\sin 2\pi\ 126t+\frac{1}{5}\sin 2\pi\ 210t\ldots\ldots\right)\right]$$

"This is, in effect, a continuous note of the original frequency (1,000 cps) but at half amplitude plus a series of notes of 958, 1,042, 874, 1,126 . . . cps, in decreasing amplitude. This spectrum of notes consists of a continuous fundamental with additional notes approximately a semitone, a tone, a third, . . . away from the fundamental. It is reasonable to suppose that such a series of tones would give the physiological sensation of pitch, but it has not been proved that there is persistence of aural image. We are dubious of the physiological deductions made in the article.

"However, we are under no doubts as to the validity of the extension of the phenomena to realiz-

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ing the communication engineer's dream of obtaining two channels in the spectrum hitherto required for one. In such a dual channel system as described in the article, every speech frequency is reduced to half amplitude and a very wide band of spurious frequencies (the original frequencies plus and minus 15, 45, 75 . . . cps) is added. Although this distortion may not make speech unintelligible, it is sufficient to make it objectionable. Furthermore, for the two-way system to operate it must be free from distortion, phase delay, and time delay between microphone and loudspeaker, which limits it to relatively short distances between terminals." (signed) J. H. Holmes and A. B. Shone, East Stour, Dorset, England, July 3, 1946.

"I should like to know whether someone can furnish a detailed diagram giving values of all components for an intercommunication system of the type described which is known to work?" (signed) I. Gelles, Philadelphia, Pa., July 8, 1946.

Rebuttal

These comments were referred to the author who supplied the following additional material. "The rotating shutter has to be silent and positioned in such a way that no transients occur when opening and closing the mouth of the tube, otherwise parasitic frequencies, which fall in the audible range, will be superimposed on the intelligence.

"Although the tube was nine feet long, that length is merely coincidental, but must be such that the acoustical impedance of the tube matches the aerodynamic impedance of the shutter. As the article was for the purpose of describing the phenomena, constructional details were omitted. The switch, whether acoustical or electrical, needs to be designed so as to quickly, but not abruptly, open or close the channel.

"Any frequency transmitted over such a circuit will be framed, but not accompanied, by side frequencies. Furthermore these side frequencies will occur in spurts, appearing only during the instants of switching from one steady state (open) to the other (closed). The transit time during which these

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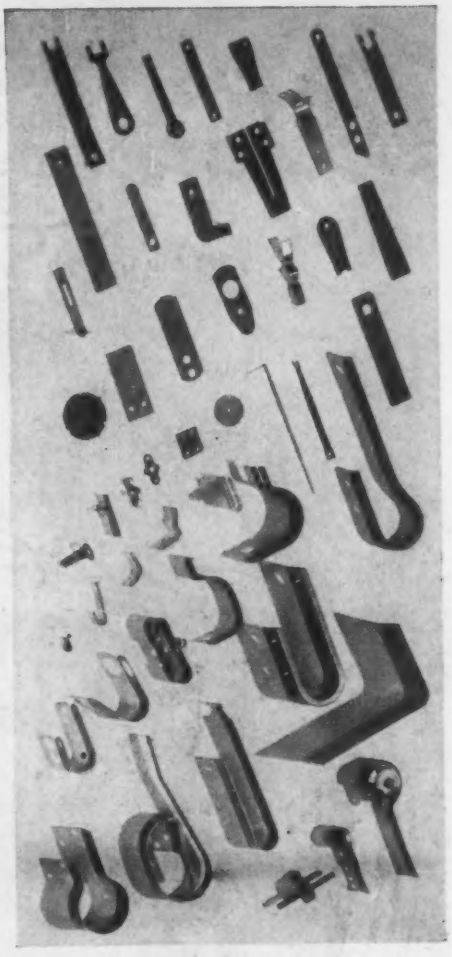

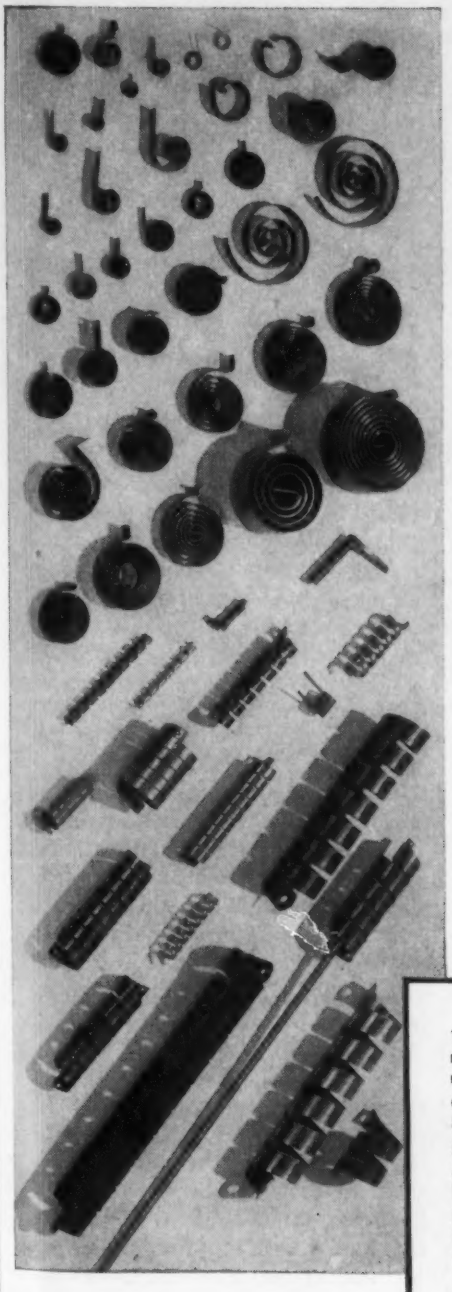

VERSATILITY—Wilco Thermometals (Thermostatic Bimetals) are designed for a wide variety of functions including . . . Temperature Indication (thermometer) . . . Temperature Control (room thermostat or hot water heater) . . . Temperature Compensation (voltage regulators and various other instruments) . . . Control of a Function with temperature change over a range of temperatures or by auxiliary heating of the Thermometal.

CHARACTERISTICS—Wilco Thermometals cover temperature ranges of maximum sensitivity from 50° to 800° F . . temperature deflection rates from minus 100° to plus 800° . . . and electrical sensitivities as required.

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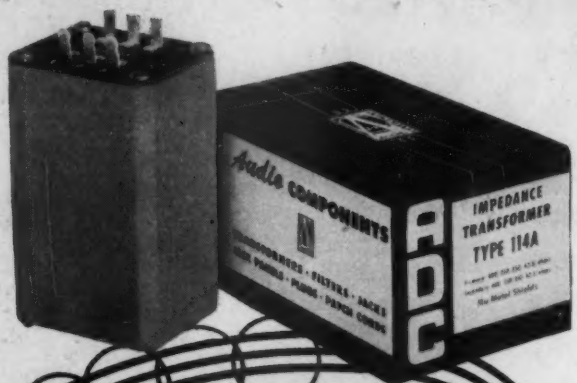

A new ADC service

For your convenience the complete line of **ADC** transformers, patch cords and plugs, filters, jacks and jack panels, is now obtainable direct from your local jobber. No more bother with mail orders. Simply call on your jobber—he will fill your order from his ready stock.

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New **ADC** policy provides for distribution through jobbers. If you do not already stock **ADC** transformers, ask for information about our new jobber set-up.

WE WELCOME YOUR INQUIRY

TYPICAL FEATURES—All units are vacuum varnish or wax impregnated, sealed with non-hygroscopic potting compound • Highest grade insulation throughout . . . will withstand voltages far in excess of normal requirements • Silver plated brass terminals—for sturdiness and easy soldering • Top or bottom mounting.

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Note to User: If your jobber does not yet stock **ADC** audio components, ask him to write immediately. Until his stock is adequate, order direct . . . we'll ship the desired items.

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side frequencies appear is made sufficiently short so that they are imperceptible to the ear, the reflex time of the interaural muscles which control the ossicle connection in the middle of the ear being long enough to cut off sudden surges.

"The rights to the invention were acquired by the Automatic Electric Company of Chicago, but they have not, as yet, done any developmental work on equipment using infrasonic switching." (signed) Dr. Angelo Montani, October 21, 1946.

The discussion is inconclusive. We delayed publishing these comments in the expectation that the aforementioned experiment could be successfully performed giving something tangible to report. We hope the correspondents will accept our futile efforts as justification for delaying publication of their comments, for which delay we are heartily sorry.

Detection of Poisonous Gases

LETHAL GASES encountered in chemical plants, mines, and other working locations can be electronically detected. Quick detection of such gases is essential because one can inhale a deathly dose in only a few minutes without knowing it. A simple portable detector can be used to give warning of the presence of many toxic gases.

Platinum Detector

The sensing element in the gas detector is a layer of platinum black (finely divided platinum) deposited on a platinum wire with an intermediate layer of aluminum oxide. Oxidation of methyl alcohol, introduced by a capillary tube from a small reservoir into the air stream that is blown over the detector and catalyzed by the platinum black, heats the detector thereby raising its temperature to 120-150 C.

Methyl alcohol does not ordinarily combine with the free oxygen of the air because of an energy threshold which repels the molecules as they approach each other closely. However, unused forces of attraction on the corners of crystals such as those of platinum can overcome this energy threshold. Thus in the

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A New Type of

FM TRANSMITTING ANTENNA

Incorporates design and structural features unique in the field of broadcasting

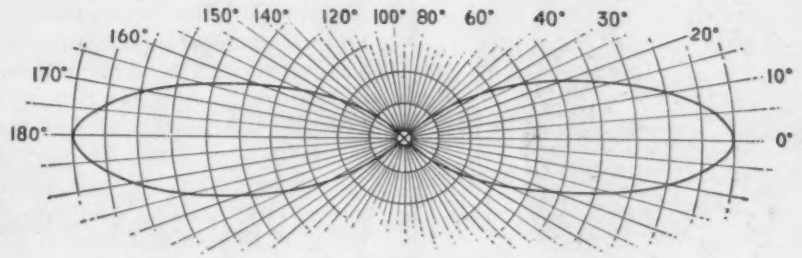
The new Workshop FM "Tower" Antenna is the ultimate in clean-cut design and performance. Complicated feed systems coupled with elaborate mechanical structures — costly, inefficient, troublesome — have been eliminated.

FEATURES

THE SINGLE SELF-SUPPORTING TOWER STRUCTURE IS THE ANTENNA!
No protruding elements to increase wind and ice load.

INSTALLATION PROBLEMS CUT TO A MINIMUM.
Complete section easily handled by two men.

TOTAL WEIGHT — 183 lbs.
This allows use of lighter and less expensive supporting structures.



Vertical Pattern of Workshop "Tower" Antenna — single section.
Actual measurements in power at 101 mc.

HIGHEST GAIN PER ANTENNA HEIGHT.
Equal or superior in gain to a 3-bay ½ wave spaced array of conventional types.

MECHANICALLY STRONG.
Four strong aluminum alloy channels rigidly mounted to reinforced circular end castings.

SECTIONS CAN BE STACKED FOR ADDITIONAL GAIN.
For higher gain Model FMT1 can be stacked on heavier lower sections—available soon.

NO DE-ICING EQUIPMENT NECESSARY.
High voltage points separated by a 15" gap. Icing effects negligible.

LESS WINDLOAD AND WEIGHT THAN ANY OTHER ANTENNA OF COMPARABLE GAIN.

LOW MAINTENANCE COST.
Simplicity of construction assures a minimum of maintenance.

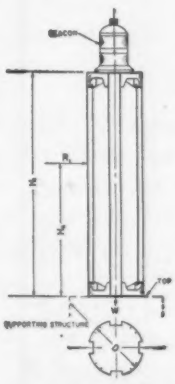
HORIZONTALLY POLARIZED.
Uses a new "wave-guide" principle of radiation (patent pending). Two short wave-guide sections arranged and fed at 90 degrees.

ABSOLUTELY NON-DIRECTIONAL.
The azimuth pattern is circular to better than a ratio of 1.1 to 1 in power.

LOW STANDING WAVE RATIO AT YOUR FREQUENCY.
Antennas are pretuned at the factory. Accurate standing wave ratio carefully measured on each antenna before shipping. Complete data supplied.

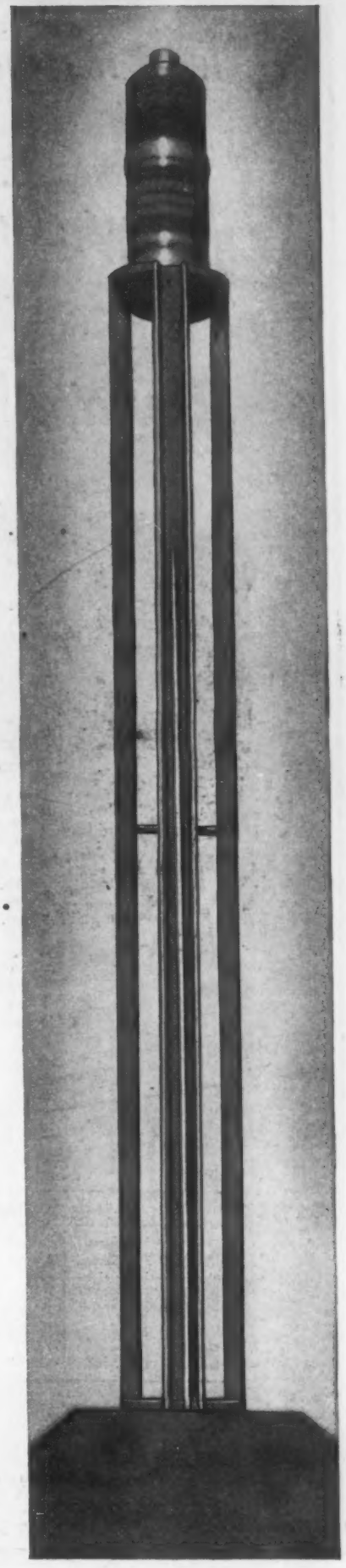
EYE APPEAL.
The neat streamlined appearance of the new Workshop "Tower" Antenna adds to the beauty of any building or tower rather than detracting from it.

PROVIDES A MOUNTING FOR A STANDARD 300mm BEACON.



ANTENNA LOAD DATA

LOAD R_1, includes 300 mm beacon 30" sq ft	409Ω
HEIGHT H_1	11' 8"
HEIGHT H_2	6' 11"
DIAMETER D	18¾"
BENDING MOMENT AT TOP OF SUPPORTING STRUCTURE moments include 300 mm beacon 30" sq ft	2,840 ft lbs
WEIGHT W exclusive of beacon	183 lbs



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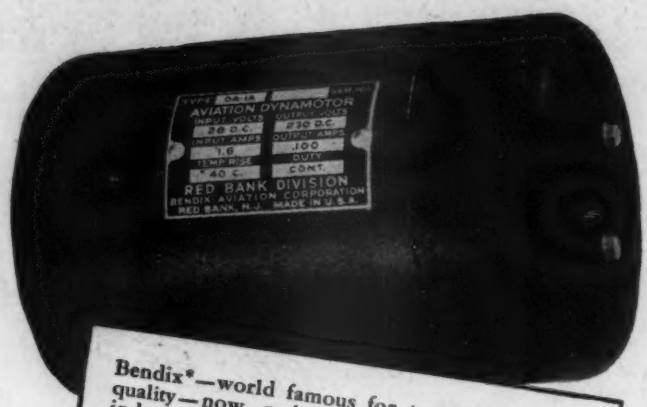

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- From 12 to 1100 volts and from 15 to 500 watts output.
- Continuous duty—enclosed.
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- Single, dual, and triple output.
- Regulated and unregulated.

Write to the address below for detailed information on these and other Bendix Dynamotors to meet your power requirements.

*REG. U.S. PAT. OFF.

STANDARD RATINGS					
Model	Frame Size	Input Volts	Output Volts	Output Watts	Approx. Weight
DA58A	2¾"	14	250	15	2 lb. 12 oz.
DA1A	3⅞"	14	230	23	5 lb.
DA77A	4"	5.5	600	104	9 lb. 12 oz
DA1F	4½"	25	540	243	11 lb. 8 oz.
DA7A	5¼"	26.5	1050	420	26 lb. 10 oz.

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Red Bank, New Jersey

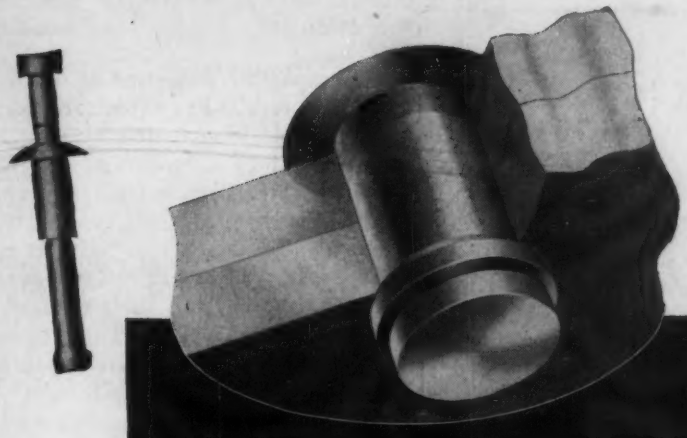
presence of a catalyst oxidation takes place.

When some gases, such as hydrogen sulphide, hydrocyanic acid, mercuric cyanide, and carbon monoxide, come in contact with the platinum black, their molecules associate with the forces of attraction thus making the catalyst ineffective. Oxidation ceases and the temperature, and consequently the resistance, of the wire falls. The wire forms one arm of a bridge which is balanced at the temperature produced during oxidation. Interruption of oxidation by a poisonous gas unbalances the bridge. The unbalance can be used to sound any desired alarm or actuate blowers or process controls through electronic amplifiers. The platinum wire is heated to 400 C for a short time to reactivate it after poisoning (too high a temperature, by causing the small crystals to combine, will reduce its effectiveness as a catalyst). Platinum is used as the catalyst because it is poisoned by most of the same gases that are toxic to personnel (Electrical Detection of Traces of Poisonous Gases in the Atmosphere, J. Boeke, *Philips Technical Review*, p 341, Nov. 1946).

Russian Research

IMPROVEMENTS in electron microscopes and other electronic equipment and components are being made in Russia. Academician A. A. Lebedev of the Soviet State Optical Institute in Leningrad has announced production of four new electron microscopes capable of resolving 40-50 Angstroms. The pictures so obtained can then be magnified an additional 50,000-60,000 times. Improvements, especially in electron gun design and use of dry disc rectifiers, make it possible to put the microscope into operation in about ten minutes against the several hours required for other such instruments. The objective table is arranged for stereoscopic photographing during examination of the object. These electron microscopes are being used in medical and biological research.

Two other projects closely parallel those of the U. S. Bureau of Standards. One, the development



High-strength, self-plugging type Cherry Blind Rivet, showing the perfectly formed blind head and the tight stem-plug.

CHERRY BLIND RIVETING

Speed excelled by no other fastening technique

Security equalled only by conventional riveting

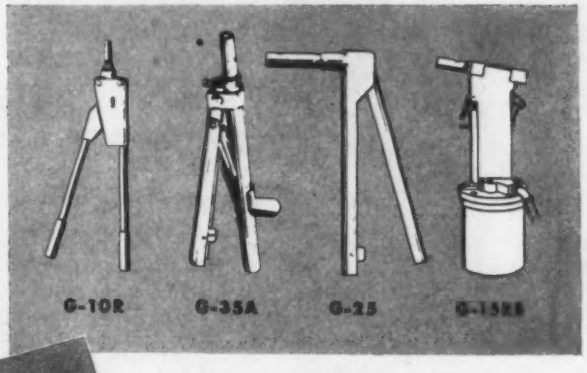
Tight-clinching, pull-through hollow type Cherry Blind Rivet, showing the perfectly formed blind head.

Cherry Blind Riveting has stirred up enormous interest since its inception during the war. This remarkable fastening technique is so fast and the results are so uniformly dependable that it has spread from industry to industry at an astonishing rate.

Installation Speed—No hammering or bucking. Cherry Blind Rivets are installed with a controlled pull from one side of the work only. Installation is a fast, one-man operation requiring only three simple steps: (1) inserting rivet in hole; (2) engaging the rivet; (3) actuating the gun. This adds up to speed, speed, speed.

Dynamic Expansion of rivet shank during installation (greater shank expansion than any other blind fastener) means tight, strong, vibration-resistant joints. Powerful controlled pull of rivet gun draws stem into rivet, *forcibly expanding* rivet to fill hole *tightly*. Cherry Blind Rivets don't work loose like nuts and screws.

Monel, Steel, Aluminum make up the Cherry Rivet materials classification. There are three types, two head styles, a range of diameters and lengths.



A series of special "guns," both pneumatic and hand-operated, have been designed for upsetting Cherry Blind Rivets. All are small, lightweight, easy to handle, positive in action.

Find out all about Cherry Blind Rivets and their many applications. Write Dept. H-120, Cherry Rivet Co., 231 Winston St., L. A. 13, Calif.

CHERRY RIVETS, THEIR MANUFACTURE & APPLICATION ARE COVERED BY U.S. PATENTS ISSUED & PENDING

Cherry Rivet
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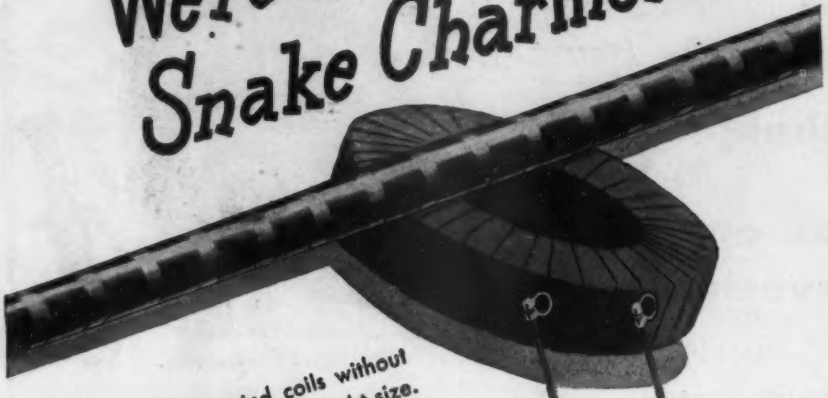
We're Not Snake Charmers



We can't wind coils without wire . . . and of the right size. Magnet wire shortages, existing for many months, have prevented us from accepting orders for coil windings using sizes not obtainable.

For your convenience we list wire sizes which we have in stock. If these sizes meet your specifications we can make prompt delivery.

PLAIN ENAMEL MAGNET WIRE
#21 - #22 - #23 - #24 - #25
#29 - #30 - #34 - #35 - #42

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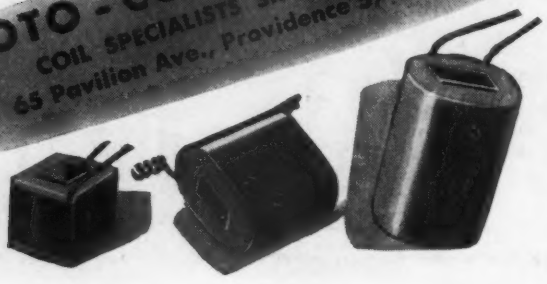


of a capacitor dielectric by B. W. Bul, has resulted in capacitors that can be used in circuits requiring a high stability despite changes in temperature. Barium titanate, having a dielectric constant over 1,000, is used as the capacitor body. It is prepared by being calcined in a furnace, plated on both sides with silver, and again calcined. The capacitor so formed has high capacitance in small volume and withstands very high voltages; it is being used in industrial technology such as induction heating, high-frequency x-ray equipment, and electron microscopes.

The other project concerns development by physicists N. S. Akulov and N. I. Yermin of an electromagnetic micrometer for measuring the thickness of protecting layers of nonmagnetic materials. Three coils are wound on an iron core. The outer two are connected in series to a galvanometer. The inner one is excited from a 30-kc source. The two detector coils are balanced against each other so that there is no galvanometer deflection. However, if the probe is brought near a magnetic material, the balance is disturbed by the distortion of the field about the coils, and a deflection is produced. The instrument is calibrated against known materials. It can be used either as a micrometer or as a flaw detector. If the nonmagnetic material whose thickness is to be gaged is not backed by magnetic material, a magnetic backing plate can be used.

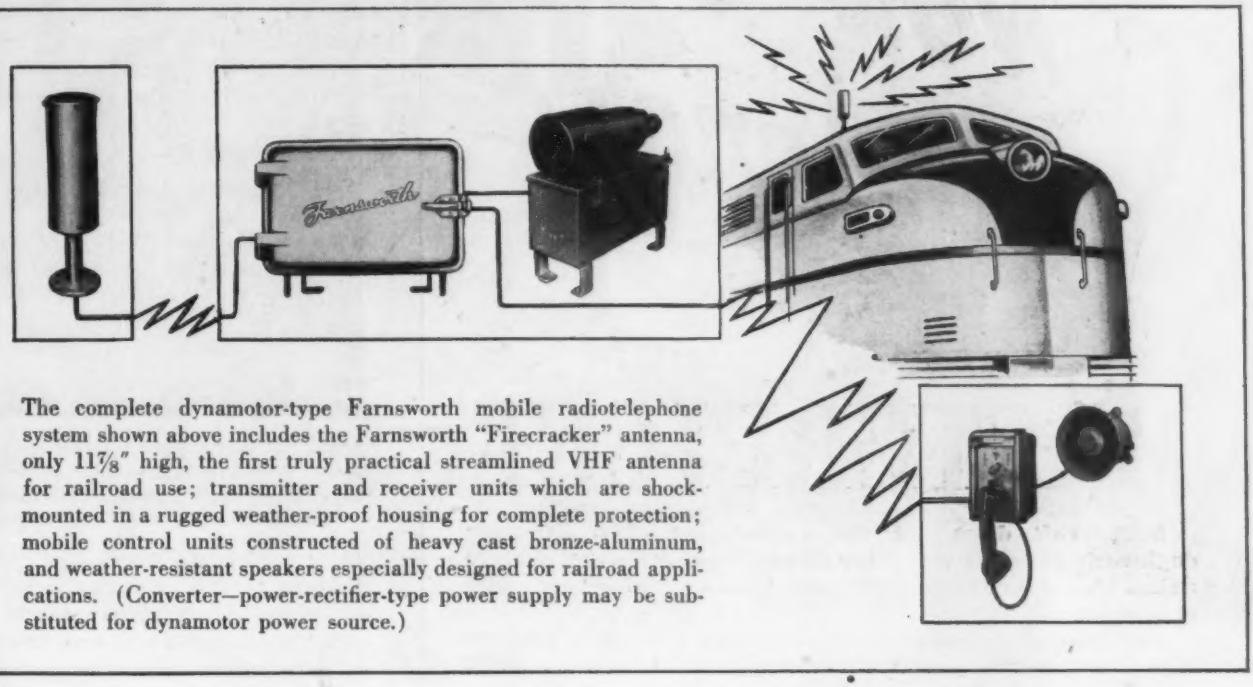
A portable telephone station has been constructed by V. A. Nevitzky at the Chief Military Navigation Management in Moscow. The telephone set consists of a piezoelectric unit that acts both as microphone and loudspeaker. The unit is being used for the telephone to marine divers. The single element in the diver's dress is connected either to the amplifier input or output depending on whether the surface operator wishes to hear or speak to him.

SURVEY OF NEW TECHNIQUES

INSTRUMENTATION is one of the major fields of application for elec-

Farnsworth

RADIOTELEPHONE SYSTEMS BUILT *specifically* TO MEET RAILROAD SERVICE REQUIREMENTS



The complete dynamotor-type Farnsworth mobile radiotelephone system shown above includes the Farnsworth "Firecracker" antenna, only 11⅞" high, the first truly practical streamlined VHF antenna for railroad use; transmitter and receiver units which are shock-mounted in a rugged weather-proof housing for complete protection; mobile control units constructed of heavy cast bronze-aluminum, and weather-resistant speakers especially designed for railroad applications. (Converter—power-rectifier-type power supply may be substituted for dynamotor power source.)

RADIO has already demonstrated its usefulness in railway operations. The design of proper specialized equipment for the practical application of this dependable communications tool in railway service is, however, dependent upon a thorough knowledge of the unique and exacting requirements of railway operation.

Because Farnsworth engineers have secured this knowledge through their pioneering accomplishments in adapting radio to railroad operations, Farnsworth is today producing VHF communications systems that have been *specifically designed and precisely developed for railway service.*

Standardized design and unitized construction are only two of many important engineering results of Farnsworth's pioneering, long-term development and field-testing program in railway radio communications. They give Farnsworth equipment these practical features:

- The same receiver, transmitter, and in some cases, power supply and remote control unit, is usable for mobile, wayside or relay installations, thus providing complete interchangeability of basic equipment.
- Because all connections are made by a single, break-away plug, transmitters, receivers and power converters can be instantly disassociated for purposes of maintenance or relocation without manually disconnecting a single wire.
- Personnel unlicensed by the FCC and without technical training can replace all units of Farnsworth systems.

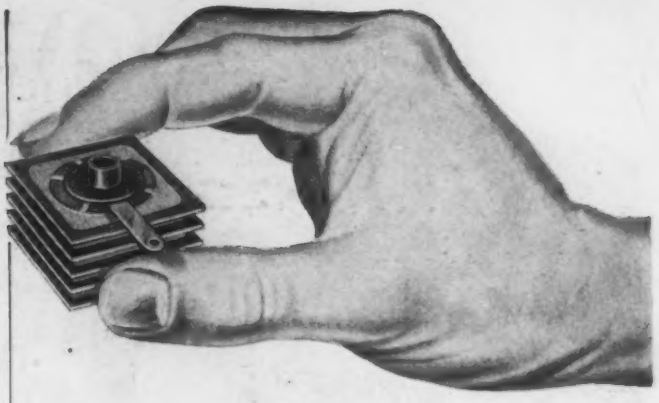
Only Farnsworth radiotelephone systems offer all these vital service and maintenance advantages. For complete information write Farnsworth Television & Radio Corporation, Dept. E-8, Fort Wayne 1, Indiana.

Farnsworth

Television · Radio · Phonograph-Radio

Farnsworth Radio and Television Receivers and Transmitters • Aircraft Radio Equipment • Farnsworth Television Tubes • Mobile Communications and Traffic Control Systems for Rail and Highway • The Farnsworth Phonograph-Radio • The Capehart • The Panamuse by Capehart

need a mite



To meet requirements for weight- and space-saving rectification in small radios, General Electric engineers have developed this tiny selenium rectifier. Less than one inch square, its use has resulted in important manufacturing economies, without loss of efficiency.

This two-ton copper-oxide rectifier is one of the largest ever made. Designed and engineered by General Electric, the ten-foot-tall unit is rated at 80 kw. It will be used in an electrochemical process, to supply constant unvarying flow of electricity over a wide range of load.

or a mammoth?

...Specify General Electric and Get the Right Rectifier for Your Designs

Mite or Mammoth? Your needs probably fit somewhere in between. But the important point is that we have a lot of experience with *all kinds and all types* of rectifiers.

This means that when you come to us with a problem involving rectification, we probably have already tackled a similar problem for some other manufacturer — and have come up with a successful solution.

Even if your application is entirely new, our engineers have a background of experience that is invaluable in selecting the type and the design of rectifier that will give you the utmost in operating economy and output efficiency.

Because we make all three of the most commonly used types of rectifiers, you can be sure of unbiased recommendations for the one that is best suited to your application.

Call on us for counsel when your next project is in the planning stage. There is no obligation. Just ask a General Electric representative to call, or write to Section A72-831, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.

GENERAL ELECTRIC

NOW Soundcraft

EACH A
POTENTIAL RECORDING

MASTERPIECE

Soundcraft discs are the culmination of a five-year engineering search for wider dynamic range, lower surface noise, freedom from "grey-cut" and "swish" in disc recording.

Soundcraft engineers have developed a coating process that now makes possible the application of high solid content, finer grained lacquers in an unusually thick, clean and uniform coating.

Check and compare these Soundcraft qualities with other blank discs you may be using now.

Background noise lowered 2—4 db
Dynamic range increased
Elimination of unpredictable "grey cuts"
Reduction of surface "swish"
Increase of sapphire life

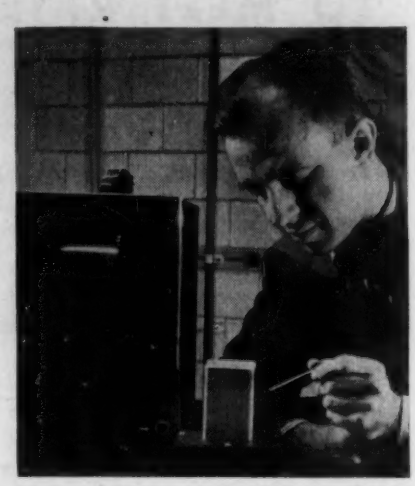
HERE'S OUR OFFER . . . . .

In order that you may test for yourself our claims for Soundcraft discs, a "Broadcaster" disc will be sent without charge to anyone detaching this page and sending his name and address to us.

REEVES SOUNDCRAFT CORPORATION
10 East 52nd Street • New York 22, New York

tronic techniques. Electronic instrumentation is finding nuclear research an especially fertile field into which to expand.

HIGHER SPEED COUNTING of radiation particles than is possible with G-M tubes can be done using a fluorescent screen. Particles from disintegrating atoms excite the screen. Light from the screen acts on



Spikes on oscilloscope indicate particles given off from radioactive material tipping wire held by Dr. Fritt-Hugh G. Marshall of Westinghouse Research Laboratories

an electron-multiplier photo-tube producing the electrical signal. Whereas G-M counters saturate at about 2,000 counts a second, the fluorescent screen and tube enclosed in a light tight box can count at rates as high as 100,000 times a second.

BECAUSE it is strong, light in weight and easily machined, Lucite acrylic resin was used as the mount for G-M tubes at Bikini.

TO DETERMINE PROPERTIES and quality of radiation from the some 400 radioactive isotopes now being used in physics, chemistry, biology, medicine, and industrial processing especially as tracers, the National Bureau of Standards has developed an improved magnetic beta ray spectrometer. Beta rays (high speed electrons) emitted from the material under test pass through the lens and impinge on a G-M tube. The beta ray particles come to a focus at a point dependent on their initial velocity, so the focal point is an indication of their energy. Baffles prevent direct rays and gamma rays from reaching the G-M tube. The spectrometer is housed in a

PRACTICAL LIGHTING IS *flexible* FOR EACH INDIVIDUAL ...FOR EACH TYPE OF WORK

Few persons see exactly alike. Even on similar jobs they have different—and changeable—lighting needs. Consider how these variations multiply when you plan to compensate for dark locations... to provide high level illumination for precision machining, fast assembly, close inspection, drafting or accounting.

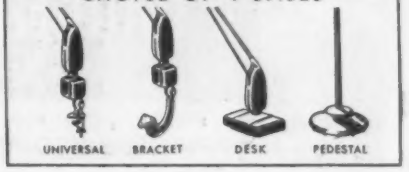
Then you'll understand why we stress the Dazor *Floating* Lamp's *flexibility*: its capacity for delivering the right amount of light for the *individual* at the right place for the *type of work*. Dazor's exclusive *Floating* Arm enables the user to raise, lower, push, pull or tilt the reflector anywhere within the broad area reached by the lamp. Once guided to the point selected, a patented mechanism holds it; there's nothing to fasten.

Your choice of advanced Dazor lighting is a logical step toward improving the safety record, increasing output, curtailing errors. It also puts you in good company. Just observe as you examine photographs of progressive concerns in popular magazines, how often Dazor *Floating* Lamps appear as "part of the picture."

Phone Your Dazor Distributor for an on-the-job demonstration of Dazor efficiency. In the event you require the distributor's name, write to Dazor Manufacturing Corp., 4481-87 Duncan Ave., St. Louis 10, Mo. *In Canada* address inquiries to Amalgamated Electric Corporation Limited, Toronto 6, Ontario.

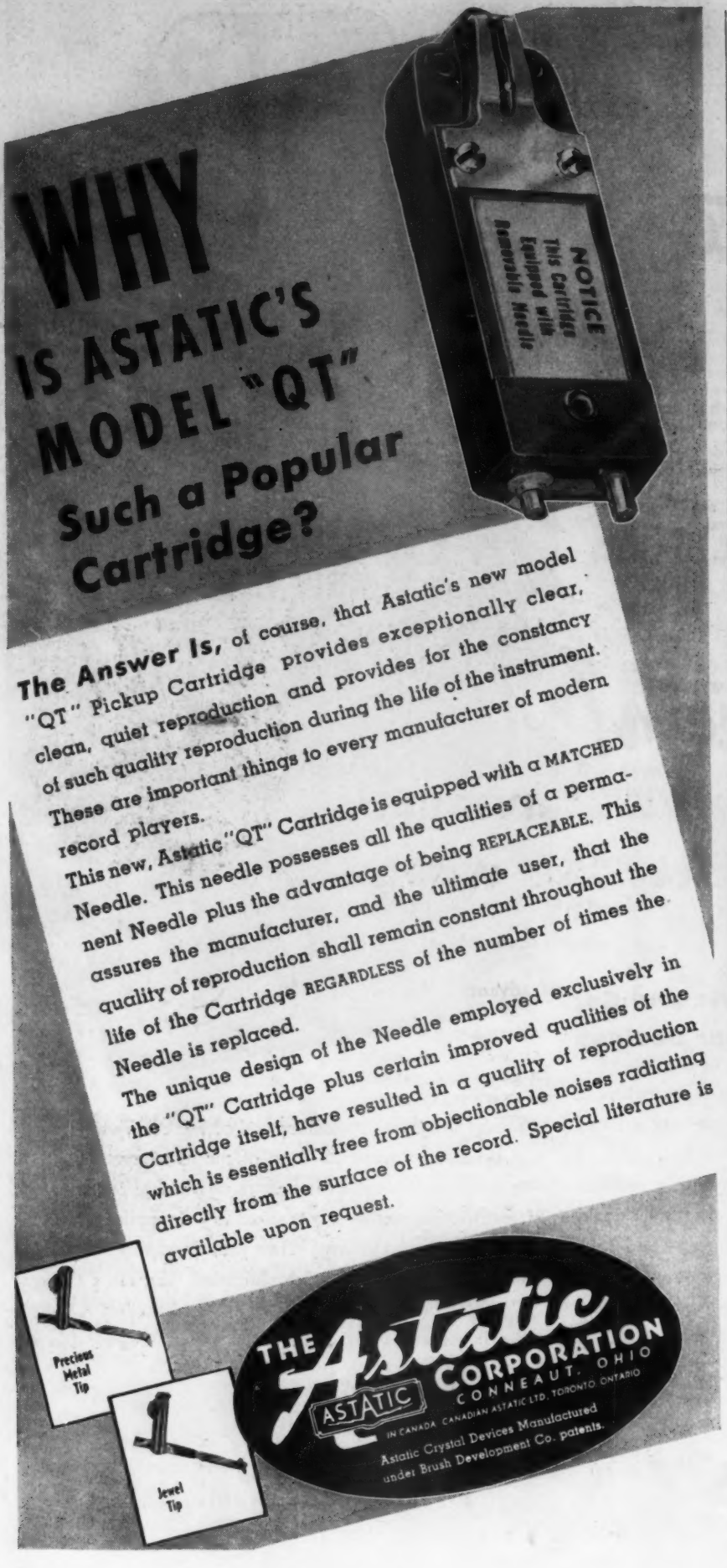
MOVES FREELY INTO ANY POSITION AND STAYS PUT—*WITHOUT LOCKING*

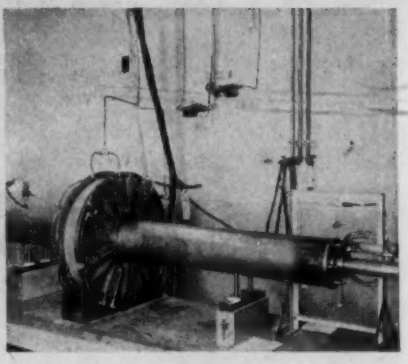
CHOICE OF 4 BASES



DAZOR FLOATING LAMPS

FLUORESCENT and INCANDESCENT

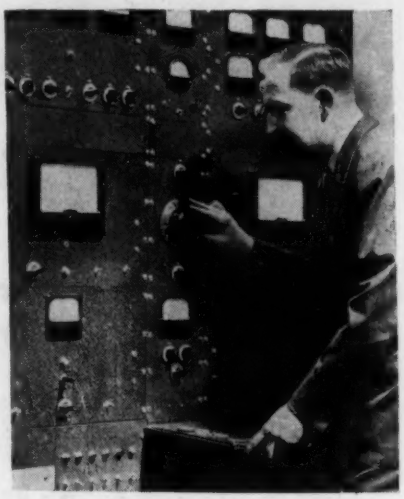

WHY
IS ASTATIC'S
MODEL "QT"
Such a Popular
Cartridge?
NOTICE
This Cartridge
Equipped with
Removable Needle
The Answer Is, of course, that Astatic's new model "QT" Pickup Cartridge provides exceptionally clear, clean, quiet reproduction and provides for the constancy of such quality reproduction during the life of the instrument. These are important things to every manufacturer of modern record players.
This new, Astatic "QT" Cartridge is equipped with a MATCHED Needle. This needle possesses all the qualities of a permanent Needle plus the advantage of being REPLACEABLE. This assures the manufacturer, and the ultimate user, that the quality of reproduction shall remain constant throughout the life of the Cartridge REGARDLESS of the number of times the Needle is replaced.
The unique design of the Needle employed exclusively in the "QT" Cartridge plus certain improved qualities of the Cartridge itself, have resulted in a quality of reproduction which is essentially free from objectionable noises radiating directly from the surface of the record. Special literature is available upon request.
Precious Metal Tip
Jewel Tip
THE Astatic CORPORATION
ASTATIC
CONNEAUT, OHIO
IN CANADA, CANADIAN ASTATIC LTD., TORONTO, ONTARIO
Astatic Crystal Devices Manufactured under Brush Development Co. patents.



Coil at center of magnetic spectrometer focuses beta rays on G-M tube

6.5-inch brass tube about 6.5 feet long with Wilson seals at both ends so that the internal vacuum need not be completely broken when radioactive samples are inserted or the G-M tube adjusted.

COMBINATION of electronic infrared, ultraviolet, and mass spectrometers at Lehigh University, which were developed by Dr. Earl Serfass, is being used to analyse volatile compounds formed during oxidation of lubricants for Army Ordnance. The

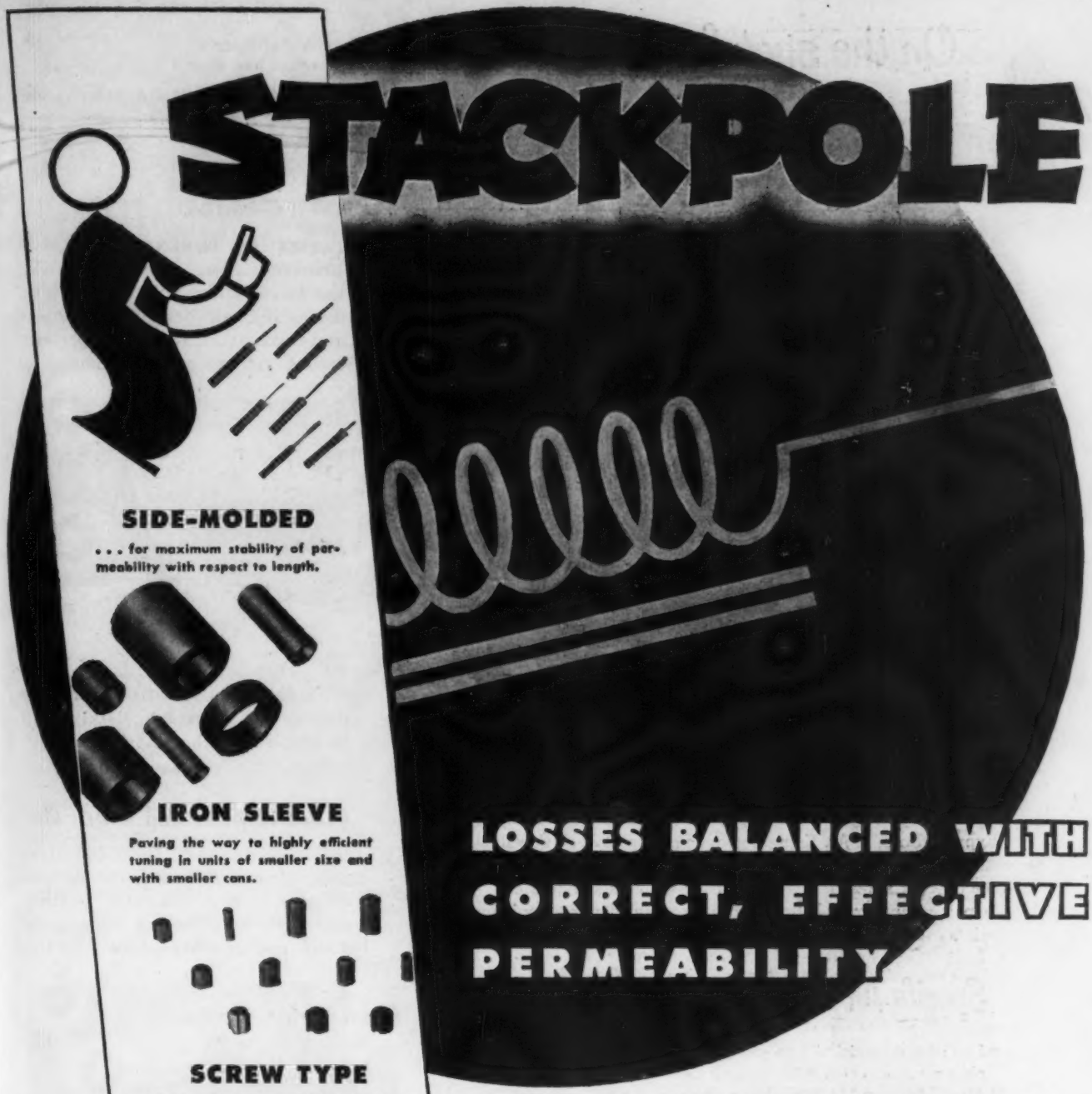


Mass spectrometer, combined with infrared and ultraviolet spectrometers, not shown, constitutes a versatile instrument for chemical analysis

versatile interlocking apparatus makes analysis as simple as tuning a communications receiver.

FRANKENSTEIN was brought to life, so Hollywood fictitiously shows it, by bolts of lightning. Dr. Arno Brasch of Brooklyn, N. Y. has found that if beams of high-voltage electrons produced by capacitron are passed through living tissue (ani-

STACKPOLE



LOSSES BALANCED WITH CORRECT, EFFECTIVE PERMEABILITY

SIDE-MOLDED

. . . for maximum stability of permeability with respect to length.

IRON SLEEVE

Paving the way to highly efficient tuning in units of smaller size and with smaller cans.

SCREW TYPE

Brass screws are eliminated from the coil field, thus greatly increasing efficiency and reducing size in many applications.

STANDARD and HIGH FREQUENCY TYPES

. . . Available in sizes, shapes and ranges for practically any requirement. Engineered to specific needs.

Optimum iron core efficiency calls for full consideration of all loss factors, then balancing these carefully against correct effective permeability.

To achieve this end, Stackpole offers several unique iron core types in addition to its standard lines. Frequently, these have paved the way to combining a low loss factor with engineering short cuts of proved economy and dependability—not only in the cores themselves, but likewise in the way in which they can be utilized in a circuit.

Based on an extremely broad background of practical application experience, Stackpole welcomes the opportunity to engineer iron cores for specific applications.

Write for Stackpole Electronic Components Catalog RC6

ELECTRONIC COMPONENTS DIVISION
STACKPOLE CARBON COMPANY, St. Marys, Pa.

RESISTORS • IRON CORES • SWITCHES

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new Ohio Electric catalog on fractional H. P. Motors

Just out! — A well-illustrated catalog which gives information on the high performance factors, all-purpose ratings and fine construction features of Ohio Motors . . . Oil Burner, General Purpose, Shell Type and Torque Motors.

New catalog describes distinctive qualities of Ohio Fractional H. P. Motors . . . vibration-free operating efficiency . . . and lists a wide variety of industrial applications.

Lower your operating costs with Ohio "Application Approved" Motors . . . Send for this catalog today!

THE OHIO ELECTRIC MFG. CO.

Chester Bland, Pres.

5908 Maurice Ave. • Cleveland 4, Ohio

mal or vegetable) the life process is in actuality interrupted. The technique may be useful in preserving foods or treatment of cancer (ELECTRONICS, p 180 Jan 1947).

A SYNCHROCYCLOTRON having 130-inch magnet faces, weighing 1,100 tons, and capable of producing energies between 200 and 250 million electron volts (mev) is being built at Carnegie Institute of Technology, Pittsburgh, Pa. through funds from the Buhl Foundation, the U. S. Office of Naval Research, and Westinghouse Electric Corp. In designing the large, high quality, low carbon steel forgings for the magnet, a scale model 1/14 the size of the final magnet has been built and is being tested at 1,000 amperes to obtain data on mechanical forces produced by large electromagnets.

The wooden man is to the same scale as the electromagnet; Joan Eccles is life size

DIELECTRIC CONSTANT and losses over a wide range of high frequencies of ceramics, liquids, glasses, polymers, and other materials are listed in two reports prepared at MIT. (PB-4658, 205 p, and PB-4660, 97 p, Dept. of Comm.)

RADAR ON one Great Lakes steamer saved two others from head-on collision during a blinding snowstorm. Three-centimeter RCA merchant marine radar on the ore carrier A. H. Ferbert showed the impending collision, and both ships were warned by radio.

How this "VIBRATION DETECTIVE" can help you put out a better product

AN MB VIBRATION PICKUP detects vibration for you—or turns it into a useful yardstick for quality-control.

In inspecting a line of air-conditioning equipment, for example, you tell at a glance whether vibration is *within acceptable limits*. Or in operational tests of machines or engines, you can check them for smoothness—or determine their *variations*. In short, MB Pickups help you *locate* trouble *before* your product gets into the field to cause extra expense and loss of good will.

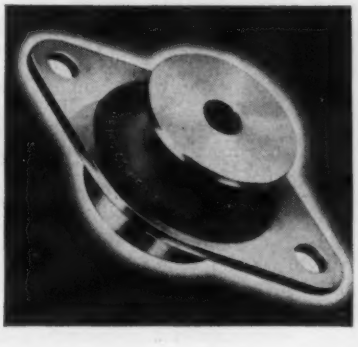
And it's an idea for process-control, too. Take the case of a ball-mill grinder, for instance. The MB Pickup could show you when material was properly milled by *changes in the pattern* of produced vibrations.

If you would like to know whether this sensitive pickup can be used in your own plant, why not let us hear from you? As foremost specialists in vibration, MB may have the answer to your problem. There's no obligation.

PARTIAL TECHNICAL DATA

- Coil which moves between permanent magnets, transforms velocity changes into voltage changes.
- Convertible for horizontal or vertical operation.
- Electrically damped.
- Dimensions: 2-13/32 x 1-19/32 x 1-19/64". Weighs 8-1/2 oz.
- Range: velocity response flat from 10 to 1000 cps. Usable to 5 cps.
- Sensitivity: about 21 mv. per .001 inch double amplitude per 100 cps. No practical lower limit on amplitude.

HOW TO REALLY ISOLATE VIBRATION AT THE SOURCE



MB's flexible, Type 5 Isomode* mount has remarkable isolation-efficiency. For it was engineered with an equal spring rate in all directions—to absorb vibrations in *all six* possible modes of motion! (That's why you can also mount it at *any angle!*) It has softness *plus* stability; large load capacity *plus* compact size.

You can make vibration end at an Isomode-supported design—and with surprising simplicity! Get acquainted with the Isomode design chart which locates your best support points for you. Write for reprint of technical paper.

** Trade Mark Reg. U.S. Pat. Off.*

SEND FOR FREE BULLETINS

No. 124A gives further details on Pickup. No. 4-5 provides helpful design information on mountings. Reprint of Technical Paper describes Isomode Simplified Design Method. No. 405 describes economical mounting of industrial machinery. Write Dep't. A6.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
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VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT
VIBRATION DIVISION

On the spot for supplies?

Get'em fast by Air Express

You get supplies and equipment the fastest possible way when you specify Air Express. This speedy service makes hay out of shipping time—delivers you what's needed in hours instead of days.

Your shipment travels at speeds up to five miles a minute by Air Express. Because Air Express goes on all flights of all Scheduled Airlines, no time is lost waiting for loads to accumulate. Regular use of Air Express keeps your business running in high gear — helps give customers better service. Frequent flights to and from points overseas make foreign shipping problems simple, too.

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- Low rates — special pick-up and delivery in principal U.S. towns and cities at no extra cost. • Moves on all flights of all Scheduled Airlines.
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Just phone your local Air Express Division, Railway Express Agency, for fast shipping action . . . Write today for Schedule of Domestic and International Rates. Address Air Express, 230 Park Ave., New York 17. Or ask for it at any Airline or Railway Express Office. Air Express Division, Railway Express Agency, representing the Airlines of the U.S.

AIR EXPRESS

AIR EXPRESS

GETS THERE FIRST

Fastest delivery—at low rates

Engine parts (36 lbs.) picked up at Portland, Ore., factory late on 10th. Delivered to Los Angeles consignee 821 miles away, 9 AM on 11th *in time.* Air Express charge — $8.84! Other weights, any distance, similarly inexpensive and *fast!*

1927 — 20th year of getting there first! — 1947

lation accuracy is 0.5 percent and maximum harmonic distortion 5 percent.

Card Counter (15)

POTTER INSTRUMENT Co., 136-56 Roosevelt Ave., Flushing, N. Y., has an electronic counter which by means of a new pickup counts sheets and cards at rates of 1,000 per second. Cards are riffled by hand, and

the pickup is moved down the edges while the count is registered on the instrument. Complete details will be supplied by the manufacturer.

Induction Heating Unit (16)

OHIO CRANKSHAFT Co., 3800 Harvard Ave., Cleveland, Ohio, announces a new induction heating machine. Suitable for both automatic and manual operation, the

unit operates from a 115-volt single-phase 60-cycle current source, and requires no water connections. The power output is 750 watts and it has a 450,000 cps frequency.

New Antennas (17)

INTERSTATE MANUFACTURING Corp., 138 Sussex Avenue, Newark 4, N. J. Designed for fast, easy installation, the new wide-band high-gain f-m

Fishing reel gears must operate smoothly at a speed of 3000 revolutions per minute or more, when a cast is executed. These gears must also withstand the strain of hauling in a fighting fish of unpredictable size and strength, thus rendering a dual purpose: speed and velvety smoothness in one direction—strength and durability in the other.

Instruments and machines have individual gear problems. For over a quarter of a century, Quaker City Gear Works has solved thousands of them and produced millions of gears of every description up to 60" in diameter for manufacturers in many diversified industries.

Aircraft controls, dental drills, electric clocks, gauges, indicators, heat controls, machine tools, radar, radios, washing machines and motion picture projectors are but a few of the many conveniences of modern progress which depend upon the heartbeat of Quaker City Gears. Your gear problem is our business, our large productive capacity is at your service.

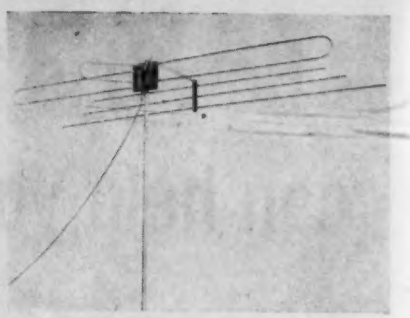
YOUR INQUIRIES WILL RECEIVE PROMPT ATTENTION

The heart of the Outdoorsman *Customatic reel illustrated above is but one of many gear trains developed by our engineers and produced in our fully equipped plant.*

Quaker City Gear Works

INCORPORATED

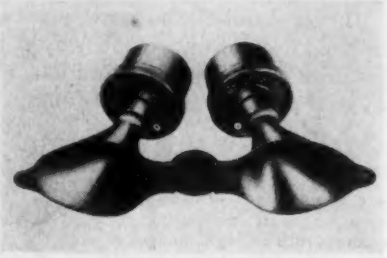
1910 N. Front Street, Philadelphia 22, Pa.



and television receptor has a blanket coverage of 44-216 mc. Reflectors are avaliable for the elimination of ghosts and for special directional effects.

Twin High-Frequency Speaker (18)

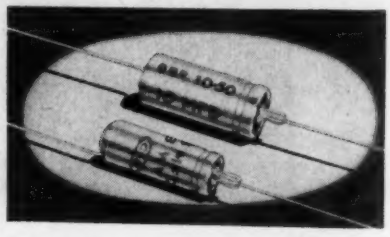
UNIVERSITY LOUDSPEAKERS, Inc., 225 Varick St., New York, N. Y. Built for use with any good low-frequency



speaker, a new twin unit has a frequency response from 2,000 to 15,000 cycles and requires no dividing network. Horizontal distribution from the horns is 100 deg and vertical coverage is 50 deg.

Electrolytic Tubulars (19)

CORNELL-DUBILIER Electric Corp., South Plainfield, N. J. Low-voltage, high-capacitance units designated



type BBR are now available and are completely described in Bulletin 100-424.

Timing Motor (20)

A. W. HAYDON Co., 111 West Main St., Waterbury 32, Conn. An ac-

ENGINEERING...

SERVICING...

is *easier* with SNC quality transformers

Here's Why!

Comprehensive research done by SNC in the field of transformer requirements has produced a line outstanding for its sturdy quality, superior design, simplicity and wide range of usefulness.

Both engineers and servicemen, particularly those in the radio field, find their work made easier due to the absence of duplication or overlap in SNC transformer specifications. And balanced design, skilled workmanship, and finest materials practically eliminate the problem of rejects.

It will pay you to investigate SNC! Write for free catalog, today.

Every SNC transformer is built to highest standards for finest performance.

Remember! SNC gives MORE applications with SMALLER inventories for GREATER profits!

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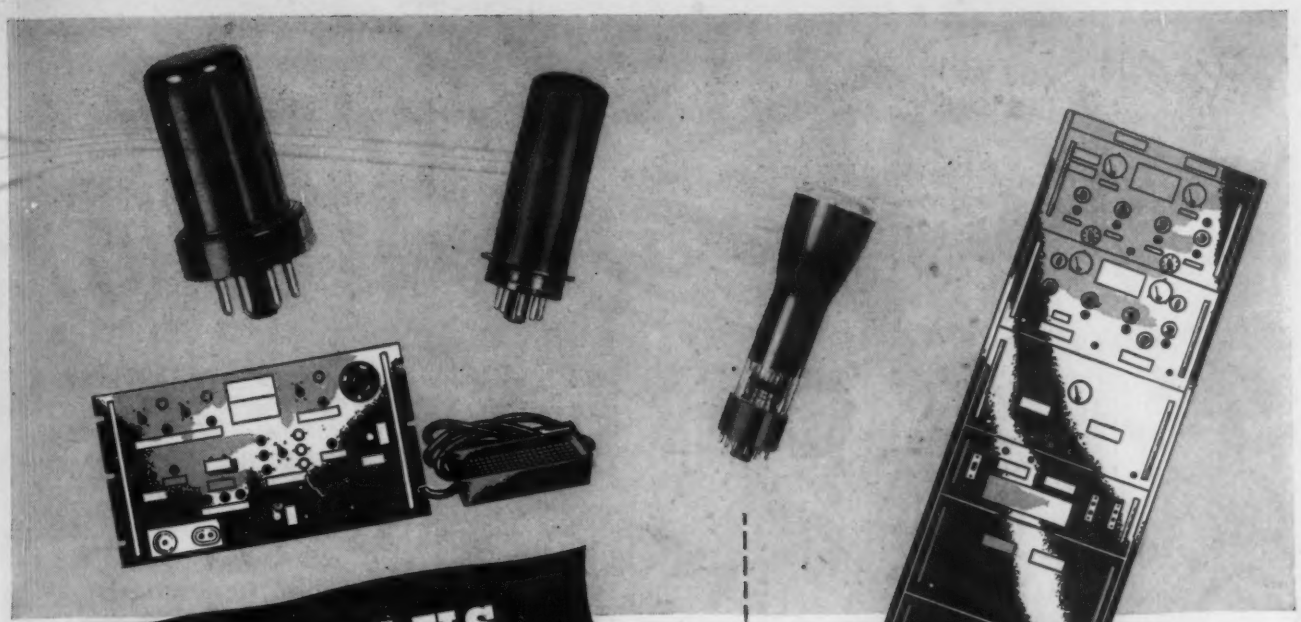
Quality Transformers

WEST LAKE AVE. NEAR LEHIGH • GLENVIEW, ILLINOIS



SURPLUS ELECTRONIC EQUIPMENT

MANUFACTURERS
JOBBERS
WHOLESALERS

The War Assets Administration, through its network of Approved Distributors, is offering electronic tubes, devices and equipment which were declared surplus by the Armed Forces. Take advantage of this great opportunity to fill your present and future needs at fraction-of-cost prices. Most inventories still permit wide selection.

Purchasing of this equipment has been simplified to a high degree. The WAA Approved Distributors listed at right were appointed on a basis of their ability to serve you intelligently and efficiently. Write, 'phone or visit your nearest Approved Distributor for information concerning inventories, prices and delivery arrangements. You'll find you can "Save with Surplus."

OFFICE OF AIRCRAFT AND ELECTRONICS DISPOSAL

WAR ASSETS ADMINISTRATION

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1282

BOSTON, MASS.
Automatic Radio Mfg. Co., Inc.
122 Brookline Ave.
Technical Apparatus Co.
165 Washington St.

BUCHANAN, MICH.
Electro-Voice, Inc.
Carroll & Cecil Sts.

CANTON, MASS.
Tobe Deutschmann Corp.
863 Washington St.

CHICAGO, ILL.
American Condenser Co.
4410 N. Ravenswood Ave.
Belmont Radio Corp.
3633 S. Racine Ave.

EMPORIUM, PENNA.
Sylvania Electric Products, Inc.

FORT WAYNE, IND.
Essex Wire Corp.
1601 Wall St.

HOUSTON, TEXAS
Navigation nstrument Co., Inc.
P.O. Box 7001, Heights Station

LOS ANGELES, CALIF.
Cole Instrument Co.
1320 S. Grand Ave.
Hoffman Radio Corp.
3761 S. Hill St.

NEWARK, N. J.
National Union Radio Corp.
57 State St.
Standard Arcturus Corp.
99 Sussex Ave.
Tung-Sol Lamp Works, Inc.
95—8th Ave.

NEW ORLEANS, LA.
Southern Electronic Co.
512 St. Charles St.

NEW YORK, N. Y.
Carr Industries, Inc.
1269 Atlantic Ave., B'klyn.
Electronic Corp. of America
353 W. 48th St.
Emerson Radio & Phonograph Corp.
76—9th Ave.
General Electronics, Inc.
1819 Broadway
Hammarlund Mfg. Co., Inc.
460 W. 34th St.
Johanns & Keegan Co., Inc.
62 Pearl St.
Newark Electric Co., Inc.
242 W. 55th St.
Smith-Meeker Engineering Co.
125 Barclay St.

NORFOLK, VA.
Radio Parts Distributing Co.
128 W. Olney Road

ROCHESTER, N. Y.
W. & H. Aviation Corp.
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SALEM, MASS.
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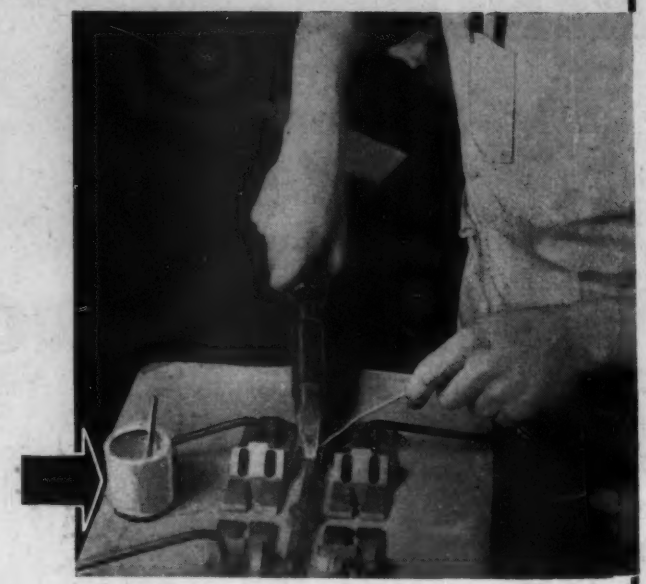
A KESTER FLUX
for Every Soldering Job!



• For every soldering operation that requires a separate flux, there's a Kester Flux in the exact formula to do the best job. Kester Fluxes are laboratory tested, and manufactured to eliminate the risk of failure in any solder requirement.

• Nearly half a century of research in the laboratory and practical experience in the plants of industrial users have provided Kester engineers with the basis for the scores of flux formulas Kester manufactures for industry today.

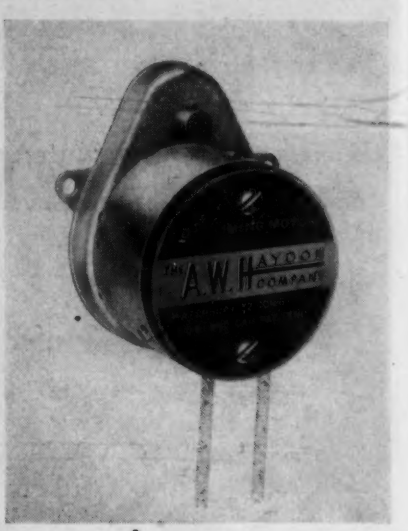
• This huge fund of flux and solder knowledge is at your disposal. Write fully at any time for prompt assistance on any solder question. There is no obligation.

KESTER SOLDER COMPANY

4204 Wrightwood Ave., Chicago 39, Illinois

Eastern Plant: Newark, N. J. Canadian Plant: Brantford, Ont.

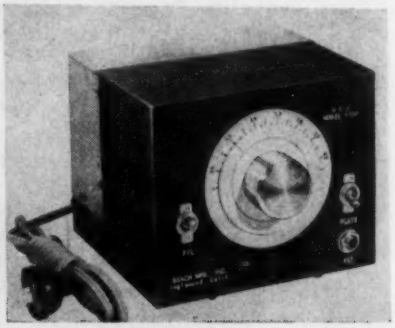
KESTER
Solder Fluxes
STANDARD FOR INDUSTRY



curate, reversible, variable speed timing motor that operates on direct current with current consumption of less than 100 ma is suitable for connecting to the output of an amplifier. Speeds up to 1,800 rpm are possible as well as one revolution an hour.

New VFO (21)

BEACH MANUFACTURING, Inc., Inglewood 3, California, has a new model 1700 variable frequency oscillator. Using an improved type of electron coupled circuit, it maintains the cathode at ground potential and almost completely eliminates frequency shift due to voltage varia-



tions. Simple and safe to use, it is also mechanically rugged. Power supply requirements are standard 115 volts, 50-60 cycles, and output is approximately one watt over the entire range. The unit, measuring 6 x 5 x 5½ inches, retails for $32.50.

Dial-Illuminated Meter (22)

MARION ELECTRICAL INSTRUMENT Co., Manchester, N. H. Applicable to all but the Hermetic line of in-

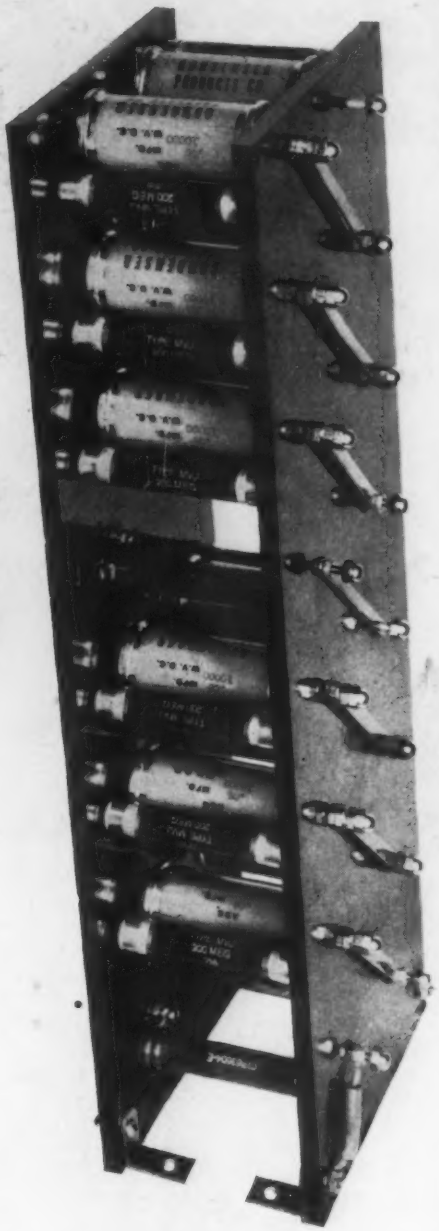
100,000 VOLT

.01 Microfarads

Filter CAPACITOR Unit

for the Princeton University

CYCLOTRON



Built with

PLASTICON* ASG Silicone-Filled GLASSMIKES

Part of oil-filled power supply built by Beta Electronics Co.

NOW AVAILABLE!

New illustrated technical booklet on uses of PLASTICON* GLASSMIKES

Obtain from your local distributor or enclose ten cents for handling and mailing when ordering direct.

*PLASTICONS—Plastic Film Dielectric Capacitors

Order PLASTICONS* from your jobber. If he cannot supply you, order direct.

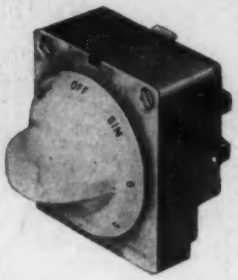
Condenser Products Company

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS

Pick

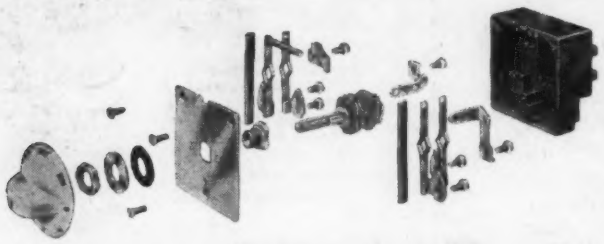
SWITCHES

FOR RUGGED, POSITIVE ACTION



Sturdy construction for dependable performance . . . *positive action every time* . . . through years of use and abuse. Top appearance, too — on the beam for sales appeal to the ultimate consumer. That's "Diamond H" electrical equipment.

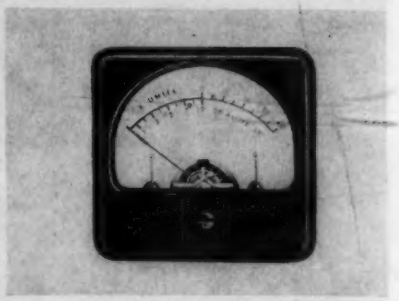
The switch illustrated was designed principally for day-in, day-out service on household ranges. It has however, a host of other applications — from glue pots, corn poppers and hot plates to ovens, sterilizers and steam tables.



Eight position switch with heavy silver contacts. 15 A. 115 V. or 15 A. 230 V. A.C. Other range-type switches with 4 and 6 positions, or designed to meet your requirements.

Let us talk switches in terms of *your* requirements. We make a complete line. Ask about "Diamond H" pilot lights, convenience outlets and thermostats.

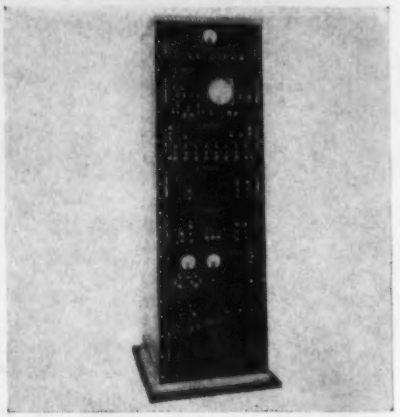
THE HART MANUFACTURING COMPANY
202 BARTHOLOMEW AVENUE, HARTFORD, CONN.



struments, a new Lucite insert makes possible the uniform illumination of meter dials in all 2½ and 3½ inch round and square types. White translucent dials are used in the new line.

Television Generator (23)

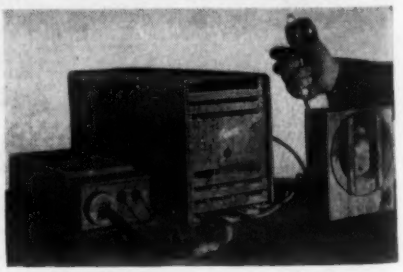
ALL POWER TRANSFORMERS, Ltd., 8A Gladstone Road, Wimbledon SW 19, England. The model 200 television generator was designed for research and developmental work and gives a complete television test signal, available either as

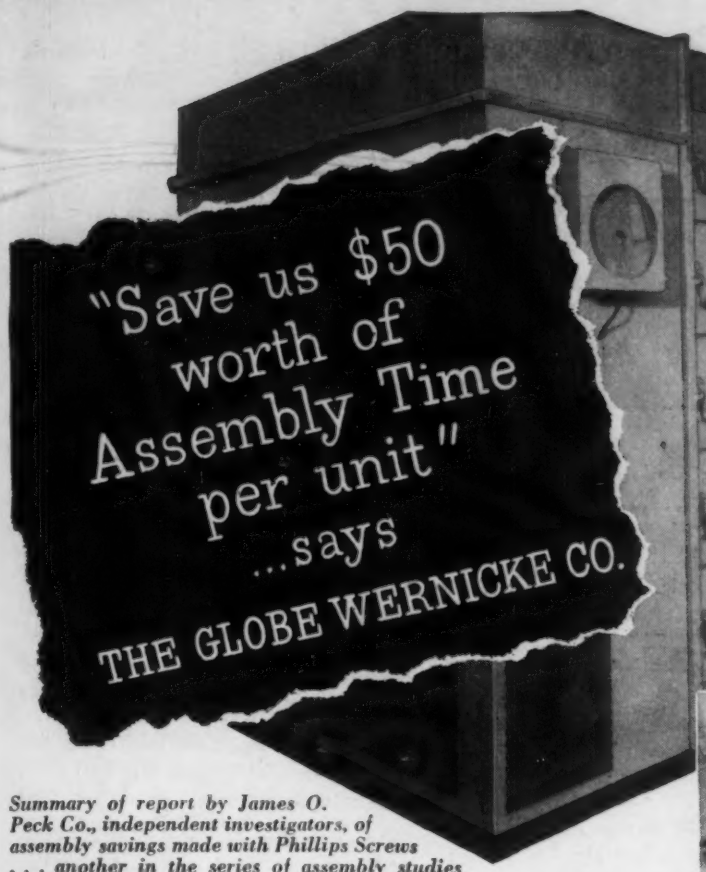


a video signal or as a modulated 45-megacycle carrier. The equipment sells in Britain for 1,500 pounds Sterling. A less expensive model for factory testing is now in production, also.

Mine Radiophone (24)

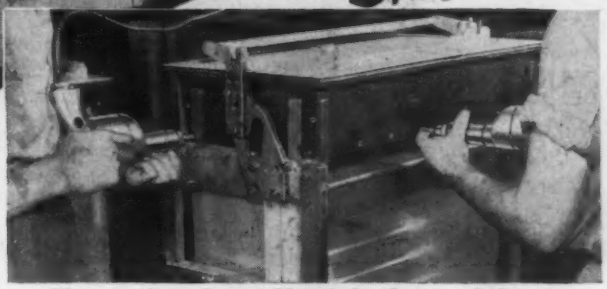
FARMERS ENGINEERING and Mfg. Co., 549 Brushton Ave., Pittsburgh





THE ICEBERG REFRIGERATED LOCKER COMPANY'S equipment for frozen food storage is made up in combinations of basic units like this 8-section (10 six-cubic-foot drawers to a section) locker.

Summary of report by James O. Peck Co., independent investigators, of assembly savings made with Phillips Screws . . . another in the series of assembly studies at prominent plants.



The complicated assembly of the drawer of the ICEBERG REFRIGERATED LOCKER . . . made without driver skids to injure work or hands, thanks to Phillips Screws. Most of the thousands of Phillips Screws used in this assembly are Type "A", self-tapping, and are power driven up, down, and sideways.

● "We manufacture these units for the Iceberg Refrigerated Locker Systems, Inc," explained the assembly head of The Globe Wernicke. "Our engineering department specified Phillips Screws throughout, and we're glad they did.

"Save us $50 worth of assembly time per unit. We can take full advantage of power drivers with Phillips Screws. No finder is needed and there's no fumbling such as we'd have with slotted screws. Since each unit requires thousands of screws, $50 is a conservative estimate of how much we save per unit by using Phillips Screws.

"Upside down or sideways . . . Makes no difference. Screws are driven with the unit in one position so that much of the driving is sideways or upside down. Difficult with slotted screws but very easy with Phillips Screws.

"No gouging or burring. Before we settled on Phillips, we tried out a lot of other type screws and found the driver would jump out and gouge the Masonite panels or burr the heads. Phillips Screws ended that, gave us better driving time with our power drivers."

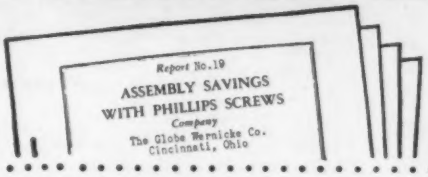
Help yourself to money-saving ideas for your assembly operations. Write for the full report on The Globe Wernicke Co. and other assembly studies . . . covering metal, wood and plastic products. Use the coupon.

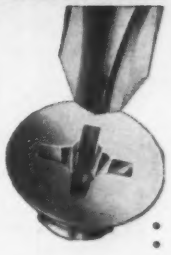
PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

24 SOURCES

American Screw Co.
Central Screw Co.
Continental Screw Co.
Corbin Screw Div. of American Hdwe. Corp.
Elco Tool & Screw Corp.
The H. M. Harper Co.
International Screw Co.
Lamson & Sessions Co.
Milford Rivet and Machine Co.
National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.
Pheoll Manufacturing Co.
Reading Screw Co.
Russell Burdsall & Ward Bolt & Nut Co.
Scovill Manufacturing Co.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Stronghold Screw Products, Inc.
Wolverine Bolt Company





Phillips Screw Mfrs., c/o Horton-Noyes
1800 Industrial Trust Bldg.,
Providence, R. I.

Send me reports on Assembly Savings with Phillips Screws.

Name .....

Company .....

Address 20-E

Electronic Regulated POWER SUPPLIES

PRECISION
ACCURACY
PERFORMANCE

Built to rigid U. S. Government Specifications

SPECIFICATIONS

INPUT—115 v. 56-60 cycle

REGULATIONS—Less than 1/20 volt change in output voltage with change of from 100-140 V.A.C. input voltage & from NO-LOAD to FULL-LOAD (over very wide latitude at center of variable range)

RIPPLE—less than 5 millivolts at all loads and voltages

DIMENSIONS—Fits any standard rack or cabinet (overall: 19 in. wide: 12¼ in. high: 11 in. deep; shipping wt.—100 pounds)

TYPE A—VARIABLE FROM 210 TO 335 V. D. C. @ 400 M. A.
TYPE B1—VARIABLE—TWO RANGES: 400-600 V. D. C. @ 125 M. A. and 600-890 V. D. C. @ 125 M. A.

CONSTRUCTION FEATURES

Weston model 301 (or equal) milliammeter and voltmeter ● Separate switches, pilot lights, and fuses for FIL and PLATE VOLTS ● All tubes located on shockmount assemblies ● Fuses mounted on front panel and easily accessible ● Can vary voltage by turning small knob on front of panel. Can easily modify Type B1 from POSITIVE to NEGATIVE output voltage ● Individual components numbered to correspond with wiring diagram.

Rigid construction: components designed to withstand most severe military conditions—physical and electrical; were greatly under-rated.

All units checked and inspected at 150% rated load before shipment.

Tube complement: {Type A: 2-836; 6-6L6; 2-6SF5; 1-VR150; 1-VR105
{Type B1: 2-836; 2-6L6; 2-6SF5; 1-VR150; 1-VR105

IMMEDIATE DELIVERY

NET PRICES—F. O. B. BALTIMORE, MD.

TYPE A—$189.00 **TYPE B1—$185.00**

Complete with tubes and ready to plug in—Prices subject to change without notice

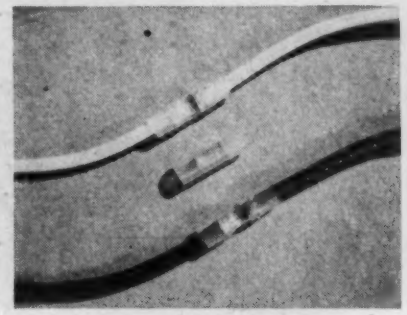
NATIONAL RADIO SERVICE CO.

Reisterstown Rd. & Cold Spring Lane · Baltimore 15, Md.

21, Pa. A rugged f-m carrier-current telephone using power from a mine trolley wire can be used successfully up to about 6 miles. The system uses a frequency of 100 kc and employs standard tubes. All units plug in for ease in servicing. Descriptive literature is available.

Pressure Connectors (25)

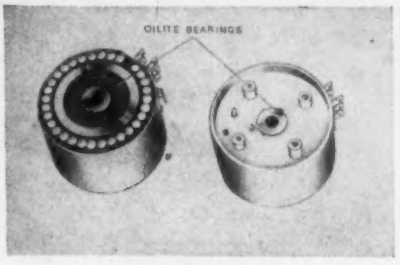
THE THOMAS & BETTS CO., Inc., 36 Butler St., Elizabeth 1, N. J. Development of the No. 25 insulated splice has been announced as the latest addition to the company's line of pressure connectors. Made of



seamless bronze, it is protected with a translucent high dielectric plastic insulation that is impervious to oil, grease, water, chemicals and acids.

Attenuators (26)

THE DAVEN COMPANY, 191 Central Avenue, Newark, N. J. announces an improved feature in its line of attenuators. Two oilite bearings are



provided on each unit, one at the switch end and the other at the detent end, made of an oil-impregnated metal. The unit is free-turning, nonbinding. There is no additional cost for this new feature.

Photoelectric Actuator (27)

GLOBE INDUSTRIES, INC., 125 Sunrise Place, Dayton 7, Ohio. Weighing less than 3½ pounds, a portable pho-

DON'T LET I.I.* SLOW YOU DOWN!

* INSTRUMENT IMPROVISATION

Turn your special instrument problem over to Marion's new SHORT RUN SHOP for a fast, economical, precise solution

Now— you can get the improved performance possible only with *custom-engineered* electrical indicating instruments, at moderate cost . . . without having to buy in production quantities! Marion's highly specialized facilities can help you to improve your product's performance and sales appeal.

HERE'S HOW MARION CAN OFFER YOU THIS SERVICE...

We have opened our SHORT RUN SHOP for the production of *special* instruments to meet your specifications — precision-built units that you can buy in *sample* lots with a minimum of red tape.

If you've been developing instruments with special characteristics in your own workshop or laboratory you'll appreciate the savings in time, money and materials that our modern, completely equipped SHORT RUN SHOP can achieve for you. And you'll enjoy working with fine, precision instruments developed by one of the nation's leading manufacturers of electrical indicating instruments. Your Marion *specials* will give the utmost in satisfaction, service and value . . . the same high standard of performance that has identified the regular line of Marion instruments for years.

Here's HOW THE SHORT RUN PROGRAM WORKS...

Just fill in our simple SHORT RUN Specification Questionnaire and return it to us . . . through your jobber or direct. Within *two days* we will send you a quotation: within an *average time* of two weeks after we receive your order, it will be shipped.

Should your SHORT RUN instrument be specified for production quantities, we will be in a position to fulfill your requirements at low cost in our regular production plant. For additional details on our SHORT RUN PROGRAM, and for copies of the Marion SHORT RUN Specification Questionnaire, see your jobber — or write direct. A copy of the Marion catalog will also be sent upon request.

MARION ELECTRICAL INSTRUMENT CO.

MANCHESTER, NEW HAMPSHIRE

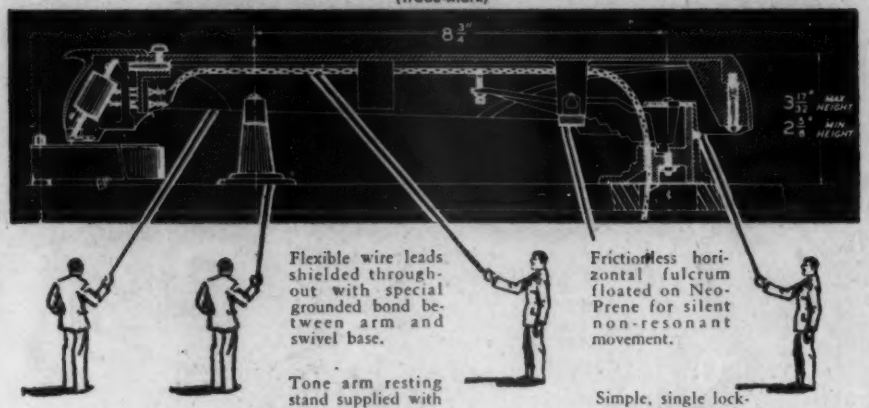
EXPORT DIVISION 458 BROADWAY NEW YORK 13, U. S. A. CABLES: MORHANEX

THE NAME "MARION" MEANS THE "MOST" IN METERS

IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO

NEW, IMPROVED TONE ARM FOR PARA-FLUX REPRODUCERS

(Trade-Mark)



All parts cast from aluminum by new, precision dies, under high pressure.

Flexible wire leads shielded throughout with special grounded bond between arm and swivel base.

Tone arm resting stand supplied with each arm matching design, equipped with durable, spring clip which prevents arm from being knocked on to turntable.

Frictionless horizontal fulcrum floated on Neo-Prene for silent non-resonant movement.

Simple, single locking set screw (in the swivel base above the turntable base) allows quick, convenient height adjustment of tone arm level.

Here's a new, improved Tone ARM, model A-16, now available to users of PARA-FLUX REPRODUCERS. It's a clean-cut, highly engineered job that embodies unique features for finer, smoother operation. *All parts are now die-cast.* Embodies new *Arm Stand* for ease in handling.

Doing one thing well . . . specialized engineering in the design and manufacture of PARA-FLUX REPRODUCERS . . . has enabled us to achieve this most efficient TONE ARM and interchangeable REPRODUCERS for affording the most realistic reproduction of transcriptions.

Our old tone arm offered many advantages as evidenced by more than 1500 now in service at AM and FM stations. Users can now exchange these old arms for the new Model A-16 Arm at a cost of only $15.00 . . . and can have the advantages of these latest refinements by returning the old arm either to us, or any jobber, listed below, and immediately obtain a new Arm, without delay.

Universal Reproducer

Lateral Only Reproducer

Vertical Only Reproducer

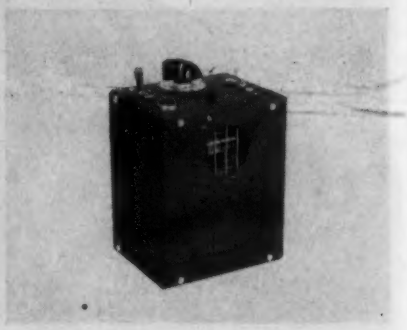
R-MC AUTHORIZED STOCKING JOBBERS:

Albany, N. Y.—E. E. Taylor Co.
Allentown, Penna.—Radio Electric Service Co.
Asheville, N. C.—Freck Radio, Refrigeration & Supply Co.
Atlanta, Ga.—Specialty Dist. Co.
Augusta, Ga.—Prestwood Electronics Co.
Binghamton, N. Y.—Federal Radio Supply
Boston, Mass.—DeMambro Radio Co.
Boston, Mass.—Radio Wire Television Co.
Buffalo, N. Y.—Dymac Inc.
Charleston, S. C.—Radio Laboratories
Chattanooga, Tenn.—W. B. Taylor Co.
Chicago, Ill.—Concord Radio Corp.
Chicago, Ill.—Tri-Par Sound Systems
Chicago, Ill.—Walker-Jimieson, Inc.
Chicago, Ill.—Newark Electric Co.
Los Angeles, Calif.—Radio Products Sales, Inc.
Los Angeles, Calif.—Radio Specialties Co.
Milwaukee, Wis.—Radio Parts Co. Inc.
Madison, Wisc.—Satterfield Radio Supply Co.
Philadelphia, Penna.—Algene Radio and Sound Co.
Portland, Ore.—United Radio Supply
Quincy, Ill.—Gates Radio Co.
Roanoke, Va.—Leonard Electronics
Rochester, N. Y.—Rochester Radio Supply
San Diego, Calif.—Coast Electric Co.
San Francisco, Calif.—San Francisco Radio Supply Co.
Scranton, Pa.—Fred P. Pursell
Topeka, Kansas—John A. Costelow Co.
Tuckahoe, N. Y.—Electronicraft
Washington, D. C.—United States Recording Co.
Winston-Salem, N. C.—Dalton Hege

Descriptive, Illustrated Bulletin PR6, upon request

RADIO-MUSIC CORPORATION

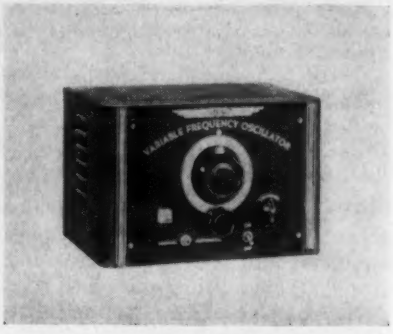
EAST PORT CHESTER, CONN.



toelectric unit comprises photoelectric tube, miniature amplifier and a sensitive relay. Batteries are self-contained and a control to adjust for ambient light conditions is furnished. A receptacle at the top of the unit makes it useful as a light operated switch for other appliance.

VFO (28)

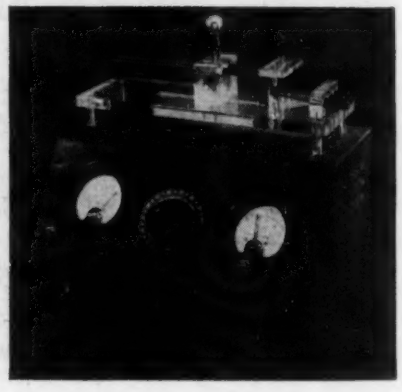
BUD RADIO, INC., 2118 East 55th St., Cleveland, Ohio. The VFO-21 is a variable frequency oscillator unit

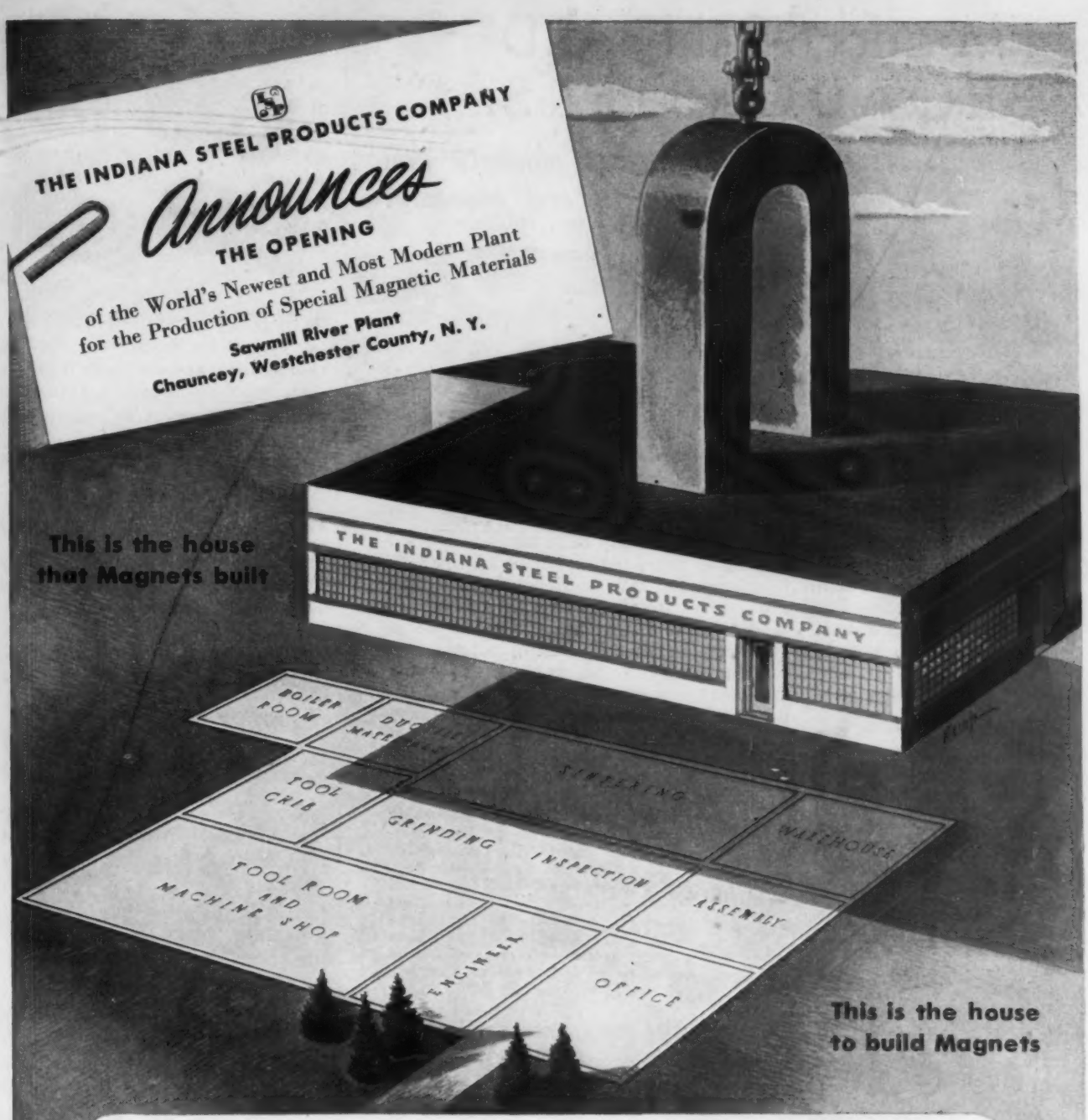


with plug-in coils, high stability and provision for switching to crystal operation.

Subminiature Triode (29)

RAYTHEON MFG. CO., 60 East 42nd St., New York 17, N. Y. The type CK608CX subminiature triode has a high mutual conductance and a





Built to meet the growing needs of an Electronic Era, this new plant was planned from the ground up for the exclusive production of special magnetic materials such as Cunife, Cunico, Vectolite, Silmanal, *Indalloy*, sintered Alnico and permanent magnet assemblies. Because of the vast developmental facilities involved in their production, these modern high-energy magnetic products provide industry of today with a flexible and advanced component which expands the scope of the widely effective cast Alnicos.

See early advertisements for specific information regarding these materials.

©1947, The Indiana Steel Products Co.

* *The designing of this plant was no less specialized than the designing of a magnet itself for special use. The experience gained in nearly one-half century as the world's largest sole producer of permanent magnets was utilized in the creation of this plant at Chauncey, Westchester County, New York.*

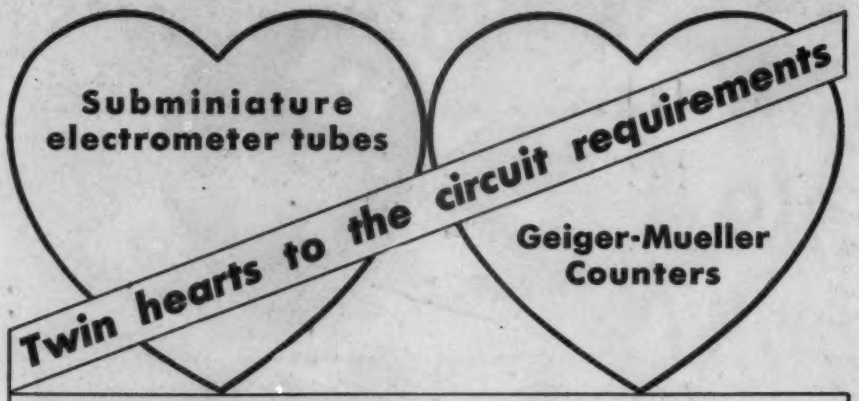
THE INDIANA STEEL PRODUCTS COMPANY

PRODUCERS OF "PACKAGED ENERGY"

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.

SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

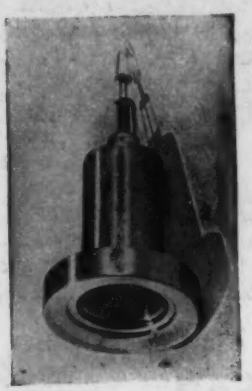
PLANTS { VALPARAISO, INDIANA
CHAUNCEY, N. Y.



Sharing the problem of nuclear measurement

Consider these factors for research . . . laboratory . . . production:

1. Low filament drain 10 milliamperes.
2. High input resistance 10^{10} ohms.
3. Versatility in instrumentation for chemical, oil, nuclear physics research, etc.
4. Ideal for electrometer applications.
5. Extreme portability—low battery drain.

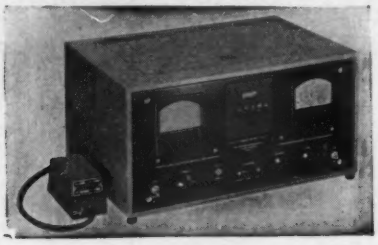


The VG series mica window Geiger-Mueller Counters are of precision workmanship and superior design. Exacting production controls assure a counter held within close tolerance limits. Designed to meet the ever increasing demand for reproducibility of tracer measurements.

Victoreen hi-megohm resistors are specially designed for the hard applications where stability with long life is required. Designed for laboratory use and fine instrumentation. Vacuum sealed in glass to cover a range of 100 to 10,000,000 megohms.

Write for technical data booklet on tubes and resistors.

Model 337



Complete Geiger-Mueller Counting System

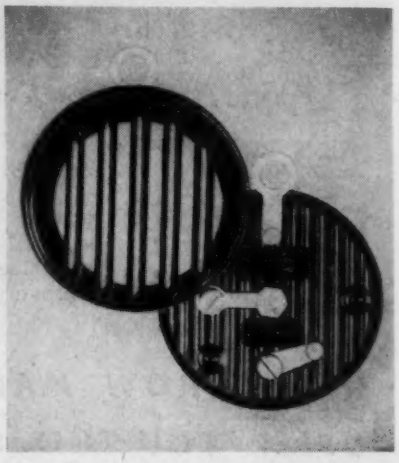
A complete Geiger-Mueller counting system and a top ranking laboratory instrument. It utilizes a scale of 64 with provisions for switching to a scale of 8. A built-in a.c. power supply provides voltages continuously variable from 0 to 2000 volts. Two new Victoreen gaseous voltage regulator units and a reliable impulse register are included. Complete and convenient front panel switching and control.

THE VICTOREEN INSTRUMENT CO.
5806 HOUGH AVENUE
CLEVELAND 3, OHIO

200-ma 6.3-v heater. It will put out a watt of radio-frequency power at about 25 percent efficiency in the band between 460 and 470 megacycles. Reduced output can be obtained up to 800 megacycles. The oscillator is illustrated atop the power supply.

Carbon Mike (30)

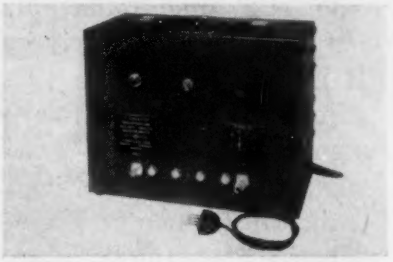
UNIVERSAL MICROPHONE CO., Inglewood 2, Calif. The A174 cartridge-type carbon microphone is light in



weight, uses a single-button construction and has a high output level. Impedance rating is 200 ohms.

I-F Converter (31)

MEASUREMENTS CORP., Boonton, N. J. The model M-275 converter is designed for use with the model 78-FM standard signal generator.



The converter makes available frequencies in the ranges 4.5, 10.7, 21.7 megacycles by the beat-frequency method. Modification of the model 78-FM is made externally.

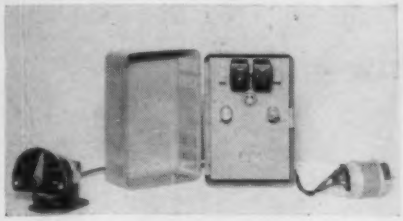
Latching Snap Switch (32)

UNIMAX SWITCH CORP., 460 West 34th St., New York 1, N. Y. Two new snap-action switches establish

volts in one to three circuits are being manufactured for door-interlock and similar use. Special units for higher voltages are available on order.

Positioning Control (35)

GENERAL ELECTRIC CO., Schenectady, N. Y. A new electronic positioning control available in packaged form consists of a control sta-



tion, follow-up device (either a selsyn or potentiometer), and a control panel. The system can be used as it stands for drives up to 1½ horsepower.

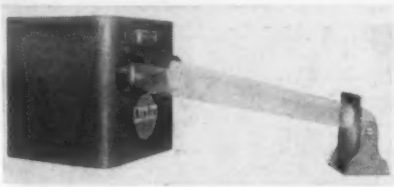
Crystal Cartridge (36)

THE BRUSH DEVELOPMENT CO., 3405 Perkins Ave., Cleveland 14, Ohio. The new BR-903 PN crystal phonograph pickup cartridge has

been engineered to withstand heat and humidity to a much greater extent than the standard line of crystal pickups, even to the extent of being servicable after boiling in water.

Photoelectric Counter (37)

RIPLEY CO., Inc., Middletown, Conn. The No. 153 photoelectric counter, operating on a 115-volt, 60-cycle cur-



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PERFECT HEARING COMFORT

• Here's beautiful efficiency: the TELEX *MONOSET* teamed with the SoundScriber to increase transcribing speed and comfort!

The TELEX *MONOSET* is the modern answer to many similar headphone requirements because:

- The MONOSET ends ear fatigue by sensible under-the-chin design.
- The MONOSET can be worn comfortably for hours—it weighs only 1.2 oz.
- The MONOSET's new built-in volume control allows convenient adjustment of signal to user.

Precision engineering gives the TELEX *MONOSET* excellent fidelity. Its rugged design invites a wide variety of commercial and laboratory applications.

Write Department AO for information and quotations. We'll be happy to show you how the TELEX MONOSET can become part of your team for perfect hearing comfort.

HEARING AT ITS BEST
TELEX INC.
ELECTRO-ACOUSTIC DIVISION
TELEX PARK
Minneapolis, Minn.

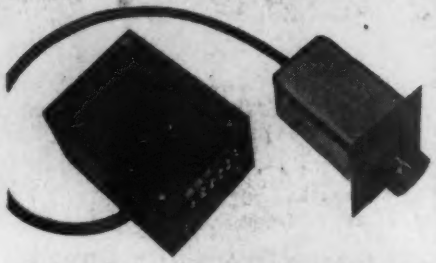
Canadian Distributors:
Addison Industries, Ltd., Toronto

FM and STANDARD BROADCASTERS

...compare this low-mass playback arm for response, fidelity and economy!

The Gray Professional Transcription Arm—the result of exhaustive research in collaboration with nationally recognized authorities on pick-up design and audio reproduction—meets all critical requirements of high compliance reproducers. It represents the only professional arm, regardless of price, that was capable of perfectly tracking the warped records used in a recent test. The Gray Playback arm has already been adopted by two of the nation's four largest broadcasting networks as standard equipment. It is furnished with or without a cartridge, yet is designed to accommodate all modern reproducers of standard make—G. E. Variable Reluctance, the new Pickering, and the better crystal types by Shure, Astatic, etc. Stylus pressure is adjustable over a wide range. This feature allows regulation for optimum pressure for the particular cartridge in use and greatly reduces record wear and surface noise. Price (without cartridge) $35.00.

Gray High-Fidelity Equalizer for Radio Station Use—



The Equalizer illustrated is specially designed for use with the Gray Playback Arm and G. E. Variable Reluctance Cartridge. It is a four position, high-quality unit of commercial broadcast station type and matches the pick-up to a 250 ohm microphone channel. This equalizer has also been adopted by the radio networks mentioned above and is priced, complete with indicating dial, at $42.50.

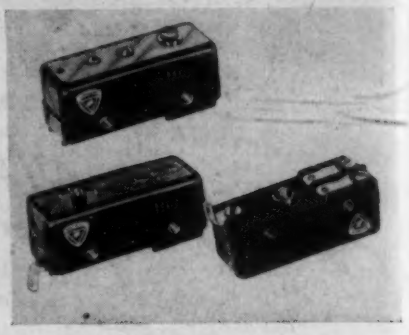
2-Speed, Synchronous Gear Drive Recording and Transcription Table—

Gray Transcription and Recording Tables incorporate a two-speed, synchronous gear drive of exclusive design. This highly perfected direct drive effectively eliminates the inaccuracy, slippage and excessive wear usually associated with indirect drive. Speed selection is instantaneous; speed is absolute. A unique record lift allows the table to rotate while the record remains stationary; makes it possible to start a record at full speed, instantly, without inertial lag. An Overhead Recording Drive with continuously variable pitch, automatic two-speed scroll and selective direction of cut completes the Recording Table.

SOUND EFFECTS EQUIPMENT includes a Variable Speed Turntable, 15-160 rpm; an Automatic Precueing Spotting Device; a Sound Effects Arm with Stylus light, plug-in cartridge, etc.; and a Dial Groove Indicator.

GRAY RESEARCH & DEVELOPMENT CO.

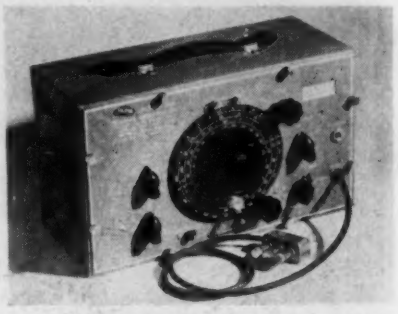
ELMSFORD • WESTCHESTER COUNTY • NEW YORK



the circuit by momentary application of force and maintain it until a restoring force is provided. Regular electrical ratings of 15 amp and 125 volts at 60 cycles are provided.

A-M and F-M Signal Generator (33)

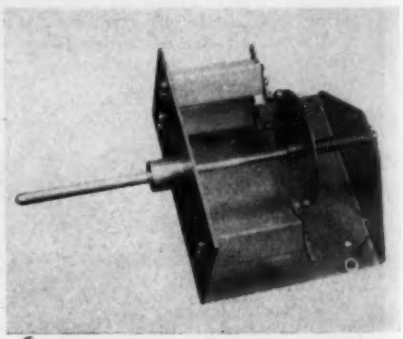
McMURDO SILVER Co., 1249 Main St., Hartford 5, Conn. The model 906 signal generator covers the frequencies between 90 kc and 170 mc on fundamental output. Amplitude modulation at 400 cycles is pro-



vided. Frequency modulation output between 90 kc and 210 mc can be made to swing (twice deviation) from zero to 500 kc. Output from less than a microvolt to 1 volt is provided.

Safety Switch (34)

J. H. BUNNELL AND Co., 81 Prospect St., Brooklyn 1, N. Y. Switches designed to break 10,000 and 20,000



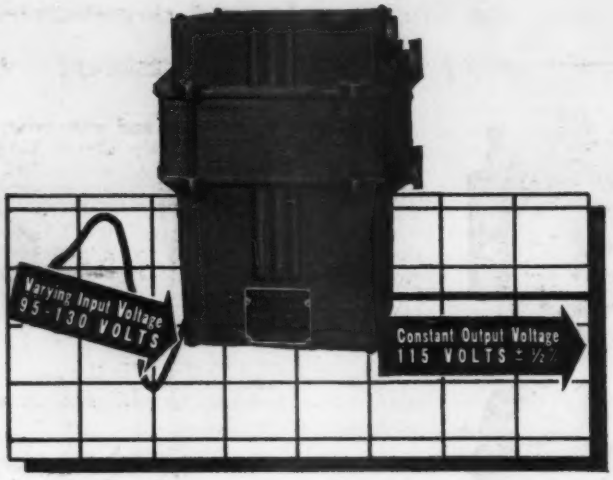
VPS* Trouble?

For a POSITIVE Cure use...

RAYTHEON Voltage Stabilizers

*Varying Power Supply need *not* prevent efficient, reliable and accurate performance of electrically operated equipment. A Raytheon Voltage Stabilizer of correct characteristics and capacity built into new equipment, or installed on old, provides constant output from varying input. Assure reliable and accurate performance of *your* equipment through *positive control* of power supply. Ask about Raytheon Voltage Stabilizers to meet *your* requirements.

Write for illustrated Bulletin DL-47-537



- OUTPUT VOLTAGE CONTROLLED to within ± ½%.
- STABILIZATION AT ANY LOAD within rated capacities.
- QUICK RESPONSE... varying input voltage stabilized within 1/20 second.
- ENTIRELY AUTOMATIC... no adjustments, no moving parts, no maintenance.

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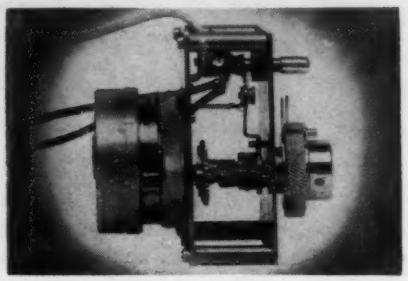
Industrial and Commercial Electronic Equipment, Broadcast Equipment, Tubes and Accessories

Sales Offices: Atlanta, Boston, Chicago, Cleveland, Louisville, New York

rent, is designed to meet industry's need for a compact, easily installed, packaged unit. An aperture in the housing permits setting for various light intensities.

Industrial Reset Timer (38)

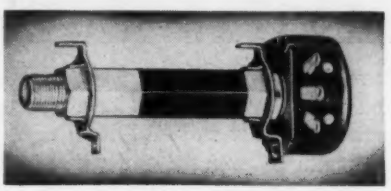
AMERICAN TIME CORP., Springfield 1, Mass. The P 147-60 panel mounted reset timer can be furnished in time cycle ranges from 15 seconds to 30 minutes and has a



1,500-watt control capacity directly on its contacts. The synchronous motor used to drive the timing mechanism can be made to shut off before the maximum time interval for which the switch is designed, by means of an adjustable stop.

Standoffs (39)

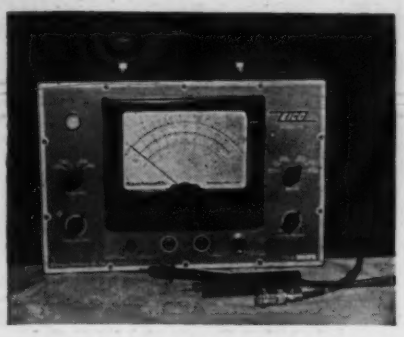
THE WINCHESTER CO., 6 East 46th St., New York 17, N. Y. A complete line of small standoff terminals designed to replace more cumbersome mounting boards is now available,



as well as 4-contact miniature connectors and the mounting control illustrated for high-voltage circuits. The type 401 control standoff fits all standard variable resistors.

V-T Voltmeter (40)

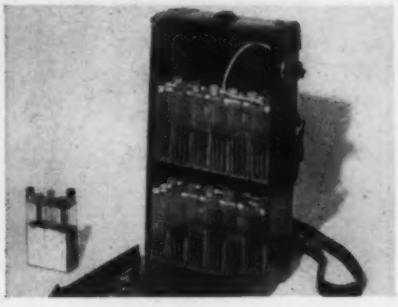
ELECTRONIC INSTRUMENT CO., 926 Clarkson Ave., Brooklyn 3, N. Y. The model 210 vacuum tube voltmeter and visual signal tracer measures d-c up to 5,000 volts and a-c up to 1,000 volts. Resistance



from 0.1 to 1,000 megohms is measured in six ranges. A new type uhf diode is used for a-c rectification and one probe is employed for all a-c readings.

Nonspill Storage Battery (41)

ELECTRONIC BATTERIES, INC., Bush Terminal Bldg. No. 4, 28-34 Thirty Fifth St., Brooklyn 32, N. Y. The Sturges 24-volt power pack illustrated contains two 12-volt Type 125-S batteries in series. They are



entirely spill-proof and do not spray acid. Such assemblies are particularly designed for use with electronic equipment in the field.

Three-Band Portable (42)

BENDIX RADIO, Baltimore 4, Md. A new portable receiver is now avail-

THE ANSWER TO TODAY'S PROBLEM—

RACON

Speakers — Horns — Horn Units

are the finest and most dependable for every conceivable PA installation

PM HORN UNIT

RACONS leadership in sound reproducer engineering has been recognized for almost three decades. RACON driver units have a rated output for peak and continuous performance far in excess of any other brands — continuous operating capacity 30 watts, peak capacity 60 watts. RACON speakers and driving units require less energy input yet they deliver more efficient sound reproduction output.

All claims made by RACON as to cutoff frequencies and acoustic lengths of speakers, power handling capacity, efficiency and frequency range of driver units are substantiated by tests made at laboratories recognized as the foremost in the industry.

RE-ENTRANT TRUMPET

Only RACON makes speakers with Racon Acoustic Cloth which is processed by a patented method giving a non-vibratory wall, thereby increasing the output of the horn without loss due to wall vibration. Supplied as a part of all re-entrant horns, and on all straight horns when so ordered. Stormproof types are guaranteed for life in all kinds of weather and temperature, regardless of climatic conditions.

There is a RACON driving unit, trumpet or speaker for every conceivable sound application—also the accessories (brackets and housings) that may be required for special purposes. It pays to choose and use a speaker line that is complete.

Send for Our Free Catalog which Describes Our Line Of:

Alnico PM Units	Standard PM Units	Straight Trumpets
Armoured Projectors	Radial Horns	Reentrant Trumpets
Demountable Horns	Cellular Horns	High-Frequency Tweeters

RACON ELECTRIC CO., INC.

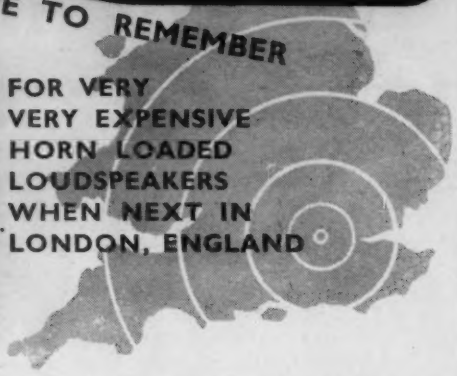
52 E. 19th St., New York 3, N. Y.

VOIGT

THE NAME TO REMEMBER

IDEAL HORN
IDEAL BAFFLE
A
B
40
30
20
10
AIR LOAD Sq. cm. at air velocity 1 cm./sec.
LOW FREQUENCY HIGH
In Curve A, the slope, shape and position of the cut off depends on horn details.
In Curve B, the lateral position depends on cone diameter.

FOR VERY VERY EXPENSIVE HORN LOADED LOUDSPEAKERS WHEN NEXT IN LONDON, ENGLAND



It will be noted that with a baffle, the air load varies throughout the scale. With an ideal HORN *(is there such a thing ?)* the load presented to the diaphragm can be CONSTANT over most of the scale.

THE WISE MAN REMEMBERS VOIGT

• Just one reason why Voigt speakers (even the domestic types) have always been . . . . .

HORN LOADED

We are not yet in post war production. Don't write now—just remember the full name.

VOIGT PATENTS LIMITED

Design registered at British Patent Office in 1935 No. 802581

ZOPHAR

Waxes, Compounds and Emulsions

ZOPHAR MILLS — QUALITY AND SERVICE — 100 YEARS — EXPERIENCE

Materials for potting, dipping or impregnating all types of radio components or all kinds of electrical units. • Tropicalized fungus proofing waxes. • Waterproofing finishes for wire jackets. • Rubber finishes. • Inquiries and problems invited by our engineering and development laboratories.

Zophar Mills, Inc. has been known for its dependable service and uniformity of product since 1846.

ZOPHAR MILLS, Inc.

ESTABLISHED 1846

117 26th STREET, BROOKLYN, 32 N. Y.

New Quick-Heating THYRATRON

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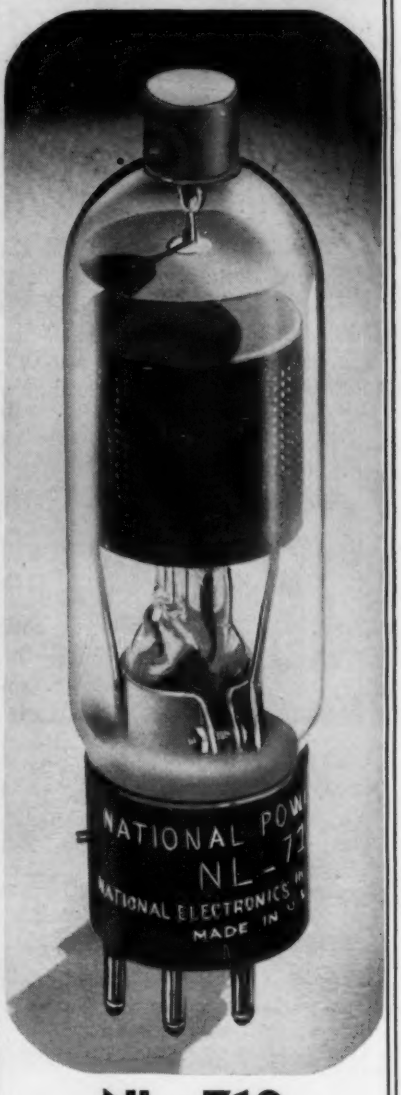
FOR IGNITOR FIRING AND MOTOR CONTROL



NL-710

2.5 amps dc - 30 amps peak

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Also a complete line of Thyratrons and gaseous rectifiers, ½ to 20 amperes, full-wave and half-wave.

WRITE FOR TECHNICAL DATA BOOK

•

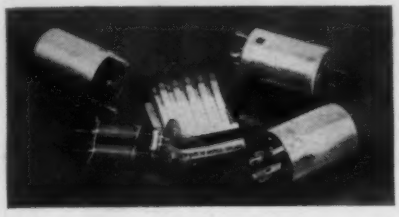
NATIONAL ELECTRONICS, Inc.

GENEVA, ILLINOIS

able for operation from a self-contained battery pack or 115-volt a-c or d-c supplies. The receiver covers the frequency ranges 195 to 410, 540 to 1620, and 2,000 to 5,800 kc. A range filter is built in for reception of weather reports in the aircraft band.

I-F Transformers (43)

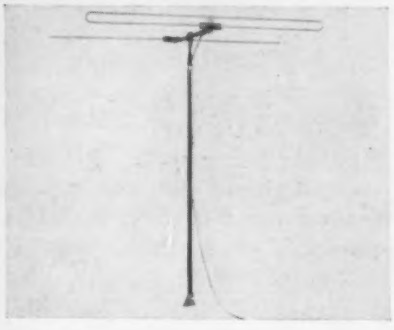
SPECIAL PRODUCTS Co., Silver Springs, Md. Specoils are a specialized line of i-f transformers designed particularly for f-m and television receivers. Optimum gain



is attained with flat bandwidth and steep skirts. They are housed in cans 1⅛ inches in diameter and 1⅝ inches high.

Folded Dipole F-M Antenna (44)

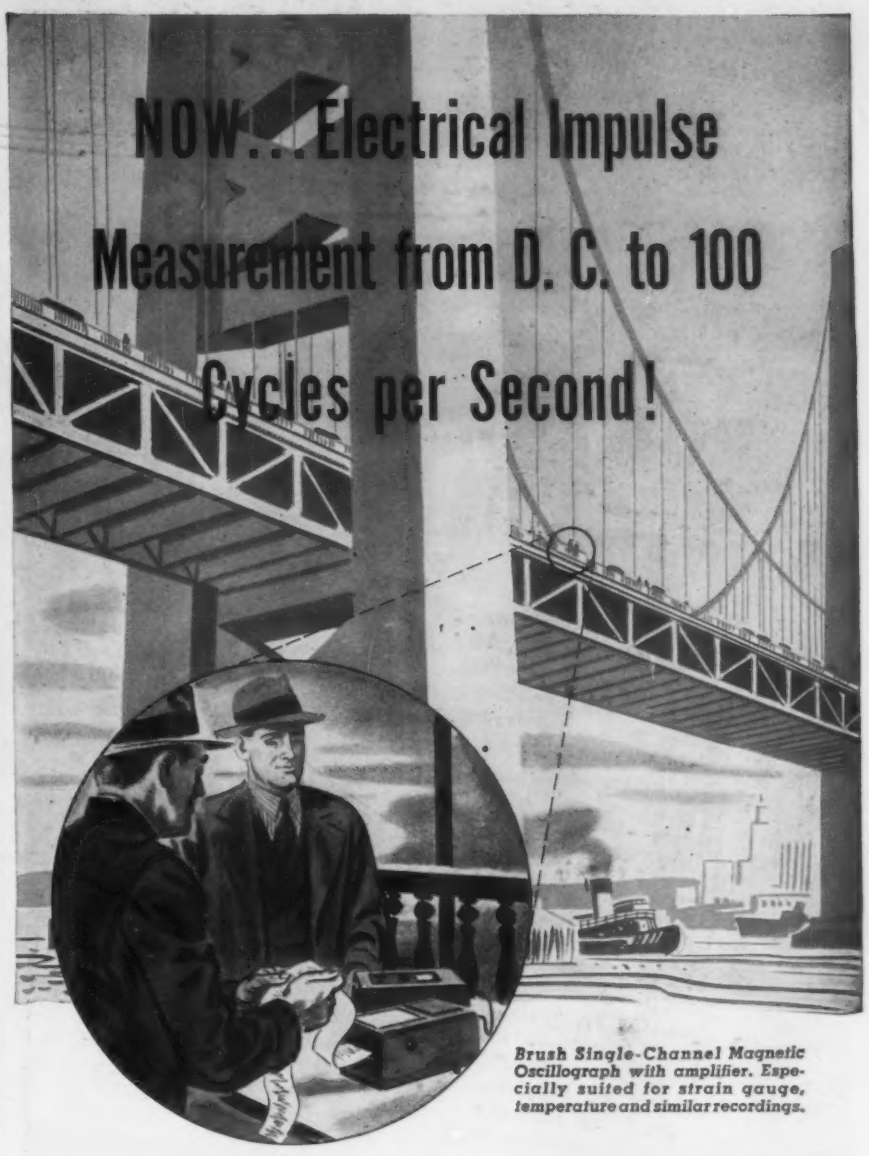
WARD PRODUCTS Co., 1523 E. 45th St., Cleveland 3, Ohio. Both the folded and straight dipole f-m antennas for use in the 44-88 mc tele-



vision range are available with or without the reflector kit. Complete information can be obtained from the company.

Vacuum Capacitor (45)

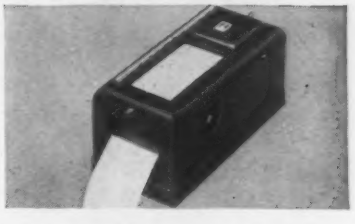
UNITED ELECTRONICS Co., Newark, N. J. The type CAP 50/-60/-30 vacuum capacitor is the first of a series for high-frequency application. All metal parts are copper and all junc-



Brush Single-Channel Magnetic Oscillograph with amplifier. Especially suited for strain gauge, temperature and similar recordings.

Brush Oscillographs make direct-inking recordings

Brush Magnetic Oscillographs may be used for making detailed recordings of electrical impulses for an almost limitless number of applications. The Magnetic Pen Motor is capable of recording a D.C. signal. Used with the BL-905 amplifier, the frequency range is from .2 to 100 cycles per second. Recordings are direct, instantaneous, ink-on-paper graphs. Can be used for recording strains, pressures, vibrations, temperatures, light intensity and countless other phenomena.



Brush Double-Channel Magnetic Oscillographs for use where two simultaneous recordings are desired —as in synchronizing problems.

Write today for detailed bulletin.

The BRUSH Development Company

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Canadian Representatives:

A. C. Wickman (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

layed pulse output. It utilizes a resonant-cavity reflex klystron oscillator. Output from 0.1 volt to 0.1 microvolt r-f can be obtained.

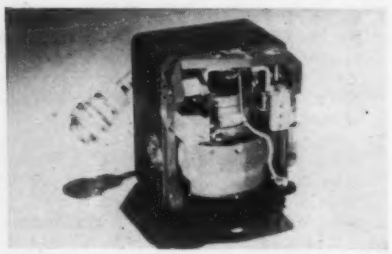
Geiger Counter Battery (48)

NATIONAL CARBON CO., New York, N. Y. The model 493 battery has been expressly adapted as a source of energy for Geiger counter radia-

tion measurement devices. It supplies 300 volts, and with nominal use during four hours each day will give service for about 350 hours.

D-C Rate Gyro (49)

FAIRCHILD CAMERA AND INSTRUMENT CORP., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. A precision d-c rate gyro now available is an angular rate-measuring device for appli-

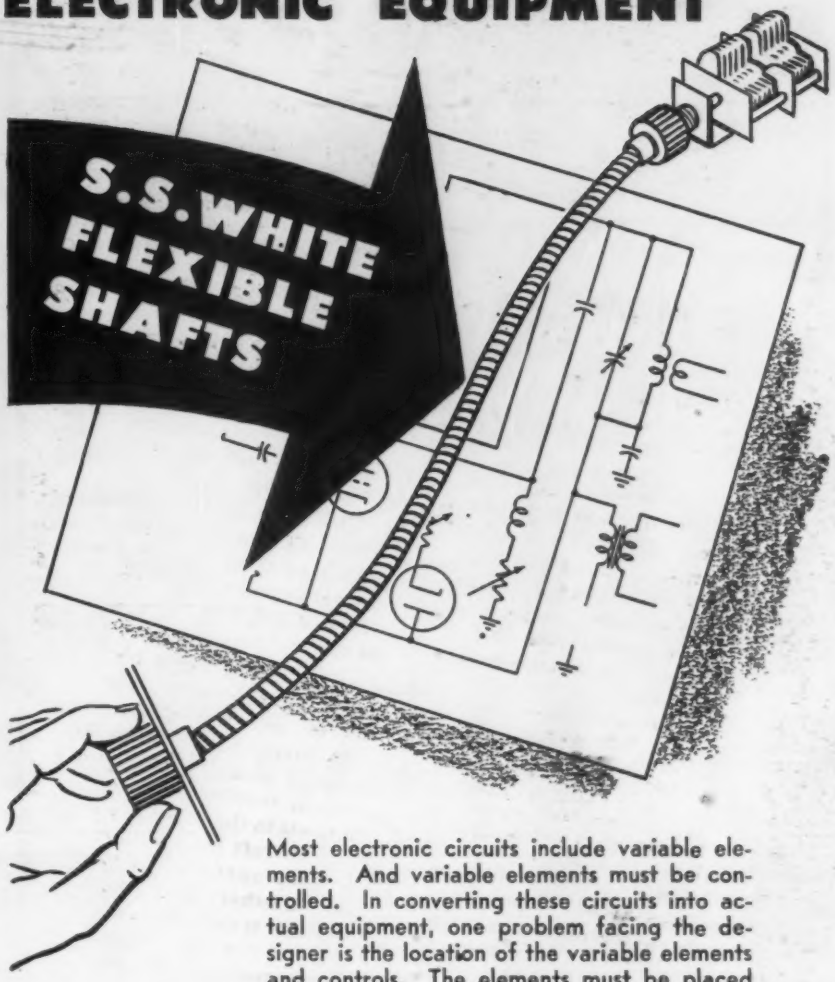


cations in which accurate measurements are required for control purposes. Such applications include telemetering, speed control, and computing systems. Full information on the device is available.

Mobile Communications (50)

ECKSTEIN RADIO AND TELEVISION CO., 914 La Salle Ave., Minneapolis 2, Minn. The model 80A receiver is designed for amateur use, but will receive the standard broadcast band. Model 80B covers the ranges 190 to 450 kc, the broadcast band,

THEY EASE THE DESIGN OF ELECTRONIC EQUIPMENT

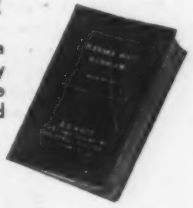


Most electronic circuits include variable elements. And variable elements must be controlled. In converting these circuits into actual equipment, one problem facing the designer is the location of the variable elements and controls. The elements must be placed for optimum electrical efficiency and ease of assembly and wiring—the controls, for operating convenience and harmonious panel arrangement.

Engineers will find a ready answer to this problem in S.S.White remote control flexible shafts. Simply use these shafts as couplings between the variable elements and their control dials. Then you are free to place both the elements and the dials where you want them. And as for performance, these shafts operate as easily and smoothly as a direct connection. They're engineered expressly for the job.

WRITE FOR THIS FLEXIBLE SHAFT HANDBOOK

260-pages of facts and technical data about flexible shafts and how to apply them. A copy sent free if you write for it on your business letterhead and mention your position.



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THE S. S. WHITE DENTAL MFG. CO.
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FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED INSULATIONS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

CURRENTLY FROM SORENSEN AT STAMFORD

SORENSEN & COMPANY, INC.
Manufacturers of
VOLTAGE REGULATORS, NOBATRONS & ELECTRONIC APPARATUS

SORENSEN & COMPANY

POWERFUL NEWS!

SORENSEN SYSTEM NOW APPLIED TO DC VOLTAGE REGULATION

The Sorensen system of AC electronic voltage regulation provides quick, accurate response to even the smallest voltage change with a minimum wave distortion and a regulation accuracy of ½ of 1%.

Arrange now to receive your personal copy of the Sorensen electronics journal "Currently", published bi-monthly.

This same electronic regulation system has been incorporated into the Nobatron, providing a source of regulated DC voltage at currents and stabilities that, in the past, was available only with batteries.

This new source of stabilized DC voltage is obtainable in six standard models operating on a 95-125 AC source of 50 to 60 cycles.

Among the more important uses for Nobatrons are DC ammeter calibration in experimental and quality control laboratories, testing of components in the automotive and aircraft industries in battery-operated relays and in other applications where it is desirable to replace a battery to guarantee continuous regulated power supply.

GENERAL AC REGULATOR SPECIFICATIONS

Input Voltage Range	(—1 model)	95-125
	(—2 model)	190-250
Output Voltage Range	(—1 model)	110-120
	(—2 model)	220-240
Load Range		25-30,000 V. A.
Regulation Accuracy		½ of 1%
Harmonic Distortion		5% Max. (2% in "S" Models)
Input Frequency Range		50-70 cycles
Inductive Power Factor Range		Down to 0.7 P.F.

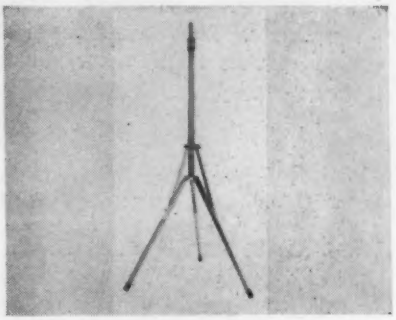
For standard voltage regulation, Sorensen Model 500 is a proven leader in its field—compact, accurate and dependable. This model typifies the Sorensen line of AC and Nobatron all-purpose voltage regulators. Let a Sorensen engineer help you with your next voltage regulation problem.

SORENSEN & COMPANY, INC.
375 FAIRFIELD AVENUE · STAMFORD, CONNECTICUT

tions are hard-brazed. Large cylindrical electrodes give low inductance. End caps are goldplated. Overall dimensions for the 50-micromicrofarad, 30-kilovolt type are 2½ by 6½ inches.

Mike Stand (46)

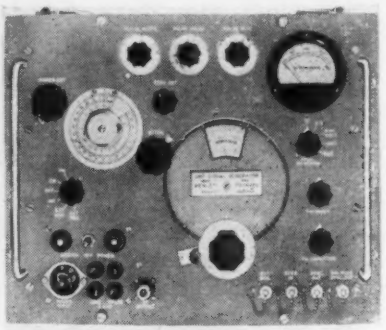
ATLAS SOUND CORP., 1451 39th St., Brooklyn, N. Y. The model CS-1 microphone stand can be collapsed

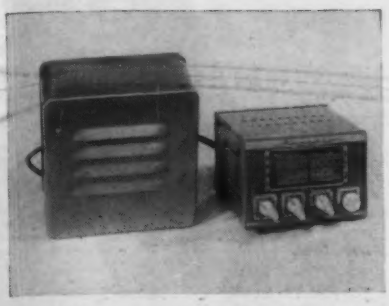


to a total length of 23 inches. Leg braces are above the legs themselves to avoid obstruction.

Kilomegacycle Generator (47)

HEWLETT-PACKARD CO., Palo Alto, Calif. The model 616A uhf signal generator is a laboratory standard for use in the range between 1,800 and 4,000 mc. It provides direct-reading frequency and voltage scales, with c-w, f-m, pulsed or de-

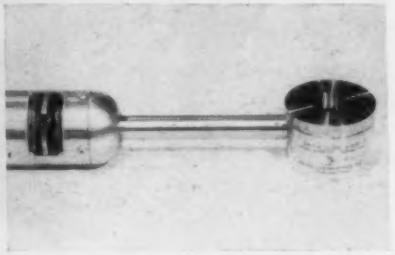




2.4 to 6.8 mc, and is therefore suitable for aircraft use. Another model is available for commonly used broadcast frequencies in foreign countries. The equipment is specifically packaged for car use and has a sensitivity of better than 5 microvolts for 0.5 watt output on all frequencies.

Artificial Ear (51)

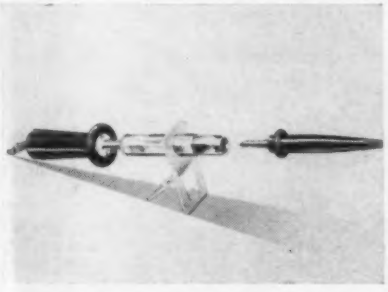
MASSA LABORATORIES, Inc., 3868 Carnegie Ave., Cleveland 15, Ohio. The model M-112 artificial ear coupler is a two-piece stainless steel structure providing either a 2 or 6



cubic centimeter chamber for obtaining response characteristics of earphones. It has been designed to fit the microphone end of the GA-1002 sound pressure measurement equipment.

Cordless Soldering Tool (52)

KWIKHEAT DIV., Sound Equipment Corp. of Calif., Glendale, Calif. The pencil-type cordless soldering tool illustrated holds its temperature for useful work about a minute and re-



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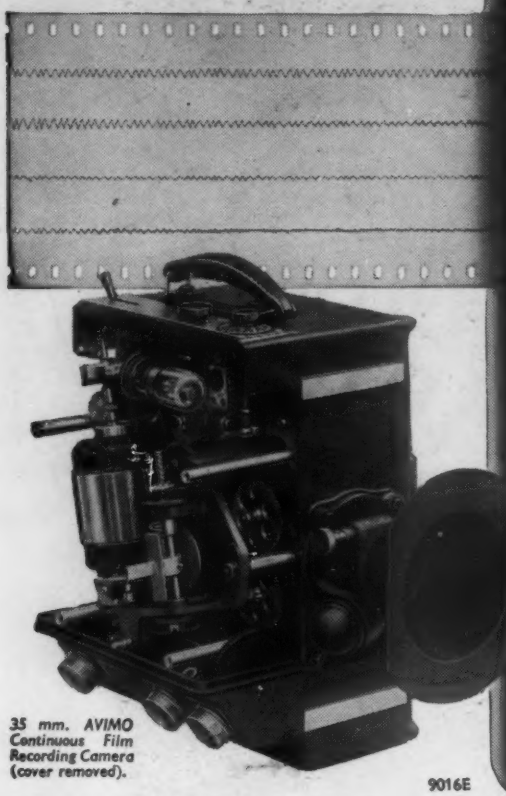
Bendix-Scintilla
Electrical Connectors
The Finest Money Can Build or Buy!

Wherever quality is called for, Bendix-Scintilla* Electrical Connectors are the logical choice. These precision-built connectors set a new standard of efficiency with their remarkable simplicity and low electrical resistance. The secret is Scinflex—a new Bendix-Scintilla-developed dielectric material. It lessens the tendency towards flash-over and creepage, and makes possible efficient performance from −67° F. to +300° F. Dielectric strength is not less than 300 volts per mil. The contacts, made of the finest materials, carry maximum currents with the lowest voltage drop known to the industry. *TRADEMARK

- Moisture-proof, Pressure-tight
- Radio Quiet
- Single-piece Inserts
- Low Electrical Resistance
- Vibration-proof
- Minimum Weight
- High Arc Resistance
- Easy Assembly and Disassembly

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK
Bendix
AVIATION CORPORATION

4 Oscillograph traces on 70 mm. paper.



35 mm. AVIMO Continuous Film Recording Camera (cover removed).

9016E

RECORDING TRANSIENT PHENOMENA

The behaviour of moving parts under actual working conditions may be studied by means of standard commercial oscillographs, which translate mechanical or electrical variations into evanescent traces on a fluorescent screen. Avimo cameras record these traces on continuous film or paper, so that they may be subsequently checked, examined, and measured.

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Our engineering and design facilities are at your disposal—details and quotations on request.

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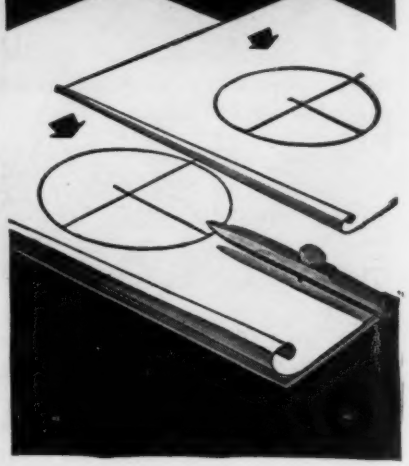

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PANEL MARKING TRANSFERS

The panel marking transfers have ⅛" white block letters. Special solution furnished. Must not be used with water. Equally satisfactory on smooth or wrinkle finished panels or chassis. Ample supply of every conceivable word or marking required for amateur or commercial equipment.

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MAIN OFFICE AND FACTORY

MALDEN

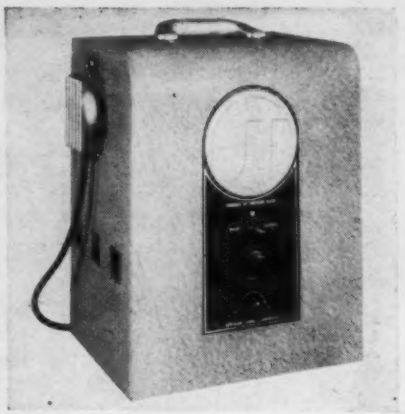
MASSACHUSETTS

M

heats in 20 seconds after reinsertion in the heater receptacle. The receptacle can be screwed into any Kwikheat soldering iron.

Marine Radiophone (53)

JEFFERSON-TRAVIS, Inc., 111 Eighth Ave., New York 11, N. Y. The model 52 portable marine radiotelephone has a carrier power output of over 5 watts in the frequency range 2 to 3 mc. Both the two



transmitter channels and the receiver are crystal controlled. A nonspillable 6-volt storage battery is furnished and charging apparatus for use on 117 volts 60 cycles is built in.

Mobile Antenna (54)

H. H. BUGGIE AND CO., Toledo 1, Ohio. A new antenna for mobile radio service requires only a single-hole mounting for a waterproof seal

and is designed so as to minimize mismatch between cable and antenna.

Small Motor (55)

GLEASON-AVERY, INC., Auburn, N. Y. A new 4-pole single-phase shaded

★ **Clarostat originated and pioneered the tube-type or plug-in resistor widely used in radio-electronic and other compact assemblies. And Clarostat is still the only one offering these features:**

MICA SUPPORT FOR WINDINGS

GLASOHMS FOR MAIN LOADS

POSITIVELY CENTERED SUPPORT

WINDINGS CANNOT SAG OR SHORT

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ADEQUATE SAFETY FACTOR

Remember this inside story when buying or specifying tube-type resistors. Don't be satisfied with less! Bulletin No. 107, with complete engineering data, sent on request.

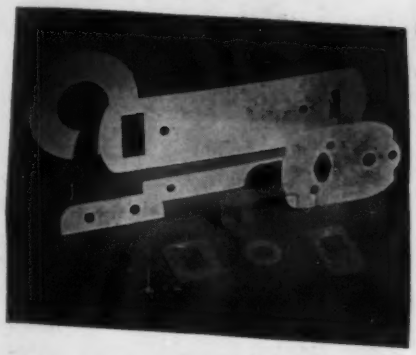
CLAROSTAT *Controls and Resistors*

CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N.Y.

PRECISION-FABRICATED

*

PLASTICS



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Years of experience in fabricating parts and products of plastics make Sillcocks-Miller an ideal source for developing practical and economical answers to your individual needs.

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ELECTRIC GLUE POTS

ALL ALUMINUM

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WATER JACKET TYPE

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Heavy cast aluminum with attached base.

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110-125 OR 220-230 VOLTS

AC OR DC

FOUR SIZES

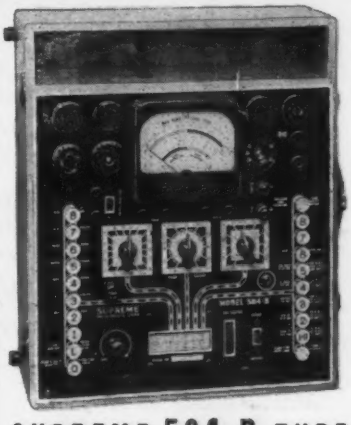
One Pint to Four Quarts

VULCAN ELECTRIC COMPANY

DANVERS MASS.

Makers of a wide variety of Heating Elements for assembly into manufacturer's own products and of Heating Specialties that use electricity.

MORE, BETTER JOBS PER DOLLAR.



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the portable lab that gives you everything.

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HERE'S WHY AND HOW

- METER—large 4-inch square-face meter, 500 microampere.
- SPEED—push-button operated.
- FLEXIBLE—simple, yet Universal Floating Filaments feature insures against obsolescence.
- SIMPLICITY—roll chart carries full data for tube setting. No roaming test leads when using multi-meter—only push a button.

SPECIFICATIONS

DC VOLTS—1000 Ohms per volt: 0-5-25 100-250-500-1000-2500.
AC VOLTS—0-5-10-50-250-1000.
OUTPUT VOLTS—0-5-10-50-250-1000.
OHMMETER—0-200-2000-20,000 Ohms. 0-2-20 Megohms.

Condenser Check:
Electrolytics checked on English reading scale at rated voltages of 25-50-100-200-250-300-450 volts.

Battery Test:
Check dry portable "A" and "B" batteries under load.

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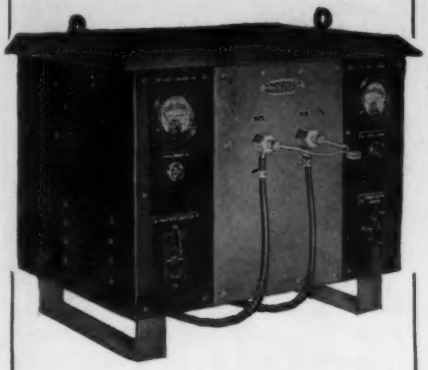
SUPREME

EXPORT DEPT.: The American Steel Export Co., Inc.
347 Madison Ave., New York 17, N. Y., U. S. A.

SUPREME INSTRUMENTS CORP., Greenwood, Miss., U. S. A.

NOW— A QUALITY 2-KW INDUCTION HEATING UNIT



For Only $650.

Never before a value like this new 2-KW bench model "Bombarder" or high frequency induction heater . . . for saving time and money in surface hardening, brazing, soldering, annealing and many other heat treating operations.

Simple . . . Easy to Operate . . .
Economical Standardization of Unit
Makes This New Low Price Possible

This compact induction heater saves space, yet performs with high efficiency. Operates from 110-volt line. Complete with foot switch and one heating coil made to customer's requirements. Send samples of work wanted. We will advise time cycle required for your particular job. Cost, complete, only $650. Immediate delivery from stock.

Scientific Electric Electronic Heaters are made in the following range of Power: 1-3-5-7½-10-12½-15-18-25-40-60-80-100-250KW.—and range of frequency up to 300 Megs. depending on power required.

Scientific Electric

Division of
"S" CORRUGATED QUENCHED GAP CO.
107 Monroe St., Garfield, N. J.

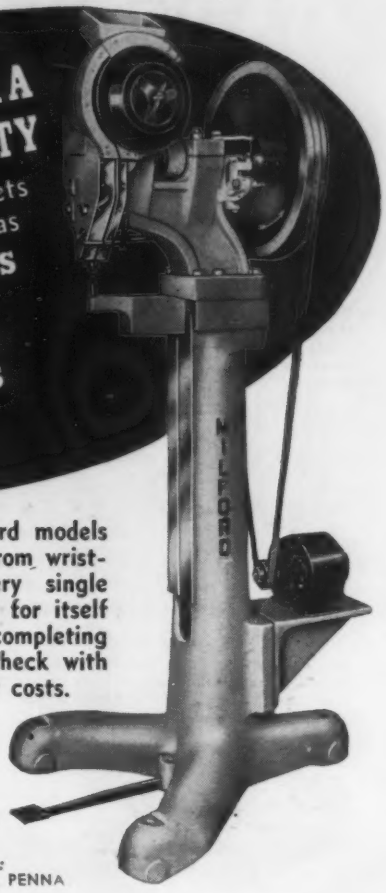
MILFORD FASTENING EQUIPMENT

MODEL No. 300-A

FOR EXTRA HEAVY DUTY

sets semi-tubular or split rivets in such diverse assemblies as

WASHING MACHINES
STEAM PUMPS
SKATES • SAWS
REFRIGERATORS
CHAINS, etc.



Here is another of Milford's 15 standard models of rivet-setters for assemblies ranging from wrist-watch bracelets to refrigerators. Every single Milford rivet-setter has more than paid for itself either in cutting costs of assemblies or completing them faster. For any fastening need, check with Milford — for ideas to save time or cut costs.

THE MILFORD RIVET & MACHINE CO.

859 Bridgeport Avenue, Milford, Conn.
1002 West River Street, Elyria, Ohio
Inquiries may also be addressed to our subsidiary:
THE PENN RIVET & MACHINE CO., PHILADELPHIA 33, PENNA

YOU SEE IT

YOU HEAR IT

This new Signaling Timer electrically controls time intervals of industrial processes with laboratory exactness. When the interval is started, a red pilot light goes on. During the interval a pointer shows the exact time elapsed. At the end, the controlled circuit is automatically opened or closed and a buzzer sounds. Sockets allow additional lights or buzzers in remote locations.

If you need accurate timing—plus visual and audible signal attention, write us today for literature on the versatile new Series S Signaling Timer. There is a model for your particular interval, voltage and frequency requirements.

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Over 400 Types of Timers for Industry

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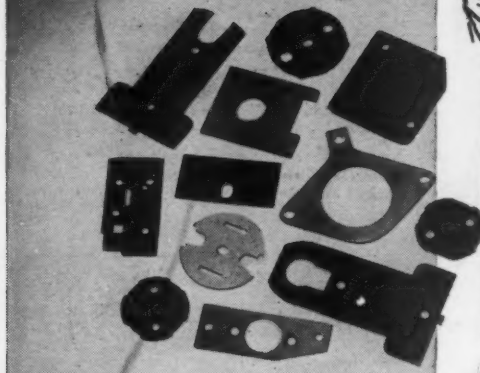
Western Electric specialists will work closely with your station engineers to provide speech input consoles tailored to your *exact* needs. Standard Western Electric components are combined into the circuit arrangements and cabinet designs you want—assuring a new high in utility, versatility, and attractive appearance. For details, write Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y., or...

WHAM
Rochester, N. Y.
has four like this.

ASK YOUR LOCAL **GraybaR**
BROADCAST REPRESENTATIVE

Baer * offers accurate fabrication of phenol and vulcanized fibre!



SEND BLUEPRINTS AND SPECIFICATIONS— NO OBLIGATION!

Check BAER FIBRE for accurate dimensioning, uniform surface, mechanical and electrical qualities, and *low cost per piece.* See how efficiently a BAER FIBRE terminal board, bushing, gasket, washer or other shape can simultaneously solve your electrical or mechanical problem...improve your product... and save you money! BAER FIBRE is precision fabricated to your specifications.

LITERATURE ON REQUEST

N. S. BAER COMPANY

MONTGOMERY ST., HILLSIDE, N. J.

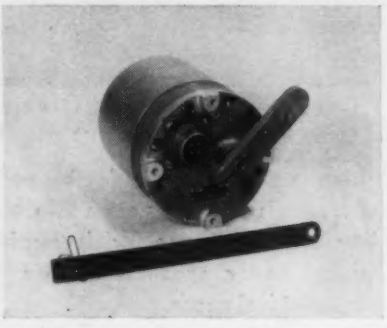
* Baer facilities are unexcelled for stamping, punching, drilling, tapping, shaving, milling, shearing and sawing.

pole induction motor, type B-30-A is a standard item for 24-volt, 60-cps use but it can also be furnished for 115-volt operation. Further details on this 1 inch-ounce torque unit are available from the manufacturer.

•

Rotary Actuator (56)

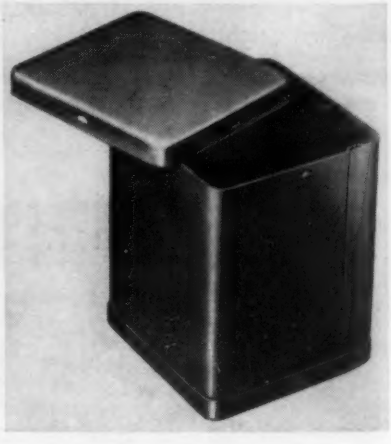
GLOBE INDUSTRIES, INC., 125 Sunrise Place, Dayton 7, Ohio. Built to deliver high torque at low speed, the Rotary Actuator weighs less than 2 pounds and is available in 24, 12 or



6-volt d-c sizes. The motor used is a permanent magnet type which facilitates dynamic braking and reversal.

Transformer Cans (57)

OLYMPIC TOOL & Manufacturing Co., Inc., 39 Chambers St., New



QUIK-LABELS
CODE CARD SYSTEM

Removable Self-Starter Strip exposes ends of Labels for you to pull!

DON'T PICK. USE SELF-STARTER STRIP TO PEEL LABELS.

FREE SAMPLES

DON'T PICK. USE SELF-STARTER STRIP TO PEEL LABELS.

1 PEEL 2 APPLY 3 IDENTIFY

LIKEWISE ON FLAT SURFACES

*Patents Pending

QUIK-LABELS
Mark Your Wires Faster

QUIK-LABELS code Wires, Leads, Circuits, Relays, Parts, etc., faster and cheaper. ● Pre-cut to exact size, QUIK-LABELS come on handy cards. ● Ready to use, they stik-quik without moistening, replace slow and costly string tags, roll tapes, decals, stencils, metal tabs, etc. ● Silicone plastic coated to resist dirt, grease, abrasion. ● *Self Starter strip automatically expose ends of Labels for you to grasp instantly — no more finger-picking.

Write for Folder and FREE Sample Cards.

W. H. BRADY COMPANY

Established 1914

Manufacturers of Self-Sticking Tape Products

240 W. Wells St., Milwaukee 3, Wisconsin

Factory—Chippewa Falls, Wisconsin

Linde SYNTHETIC SAPPHIRE
Has High Electrical Resistance

LINDE synthetic sapphire offers specific advantages for electronic uses. Sapphire maintains these properties at elevated temperatures.

Dielectric Constant	7.5 to 10
T_e Point (Temperature at which resistance becomes 1 megohm)	1,214 deg. C. to 1,231 deg. C.
Melting Point	2,030 deg. C.
Thermal Conductivity (cal. sec.$^{-1}$ cm.$^{-1}$ deg. C.$^{-1}$ at 500 deg. C.)	0.015
Thermal Expansion Coefficient (per deg. C. x 10^6 at 1,000 deg. C.)	8.3 to 9.0

Write for the LINDE Synthetic Sapphire Technical Data Sheet No. A-1.

THE LINDE AIR PRODUCTS COMPANY

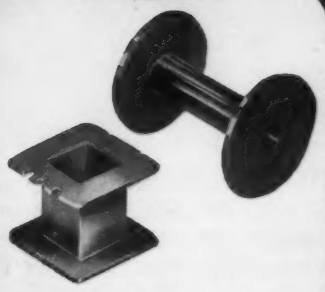
Unit of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, N. Y.

In Canada:
Dominion Oxygen Company, Limited, Toronto

The word "Linde" is a trade-mark of The Linde Air Products Company

Molded Phenolic
COIL FORMS • BOBBINS



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Coil forms or bobbins, made to your specifications.
Our mold charges are lower than were formerly considered possible.

Send print for prompt quotation

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MOLDED PRODUCTS CORPORATION
4440 Elston Avenue • Chicago 30

New Line KENYON

ISOLATION TRANSFORMERS

TYPE	VA	WT (lbs.)	L	W	H	ML	MW	FIG	LIST PRICE
I-10	25	2½	3⅝	2 11/16	3¾	3⅛	2	A	8.30
I-14	100	7½	5 3/16	3⅝	4¾	4 11/16	2½	A	14.00
I-18	250	14	6⅛	5½	5	5⅝	4½	A	22.50
I-22	750	50	9¾	7 3/16	6 3/16	4¾	6 3/32	B	59.00

Isolation Transformers with electrostatic shields. (Ratio 1:1) 115 Volts, 50/60 Cycles. Supplied with cord, plug and receptacle.

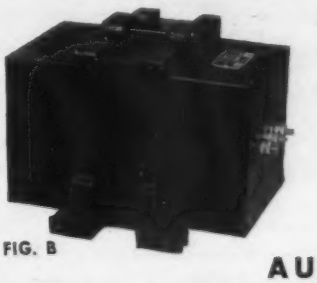


FIG. B

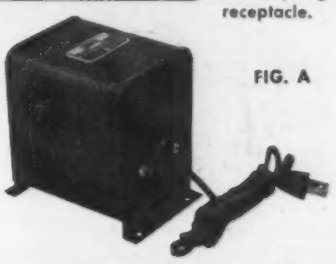


FIG. A

AUTO TRANSFORMERS

Auto Transformers 230/115 Volts, 50/60 Cycles.

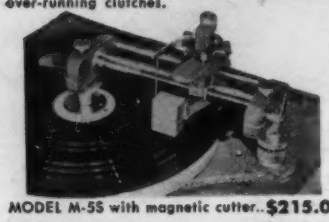
Write for details today on KENYON's *new line.*

TYPE	VA	WT (lbs.)	L	W	H	ML	MW	FIG	LIST PRICE
I-40	50	2½	3⅝	2 11/16	3¾	3⅛	2	A	7.95
I-44	100	3½	4⅞	2 11/16	3¾	4⅜	2	A	9.55
I-48	250	8	5 3/16	3⅝	4¾	4 11/16	2½	A	14.90
I-52	500	14	6⅛	5½	5	5⅝	4½	A	22.00
I-56	1000	40	8½	7 3/16	6 3/16	3½	6 3/32	B	43.00

KENYON TRANSFORMER CO., Inc.
840 BARRY STREET NEW YORK, U. S. A.

HARVEY
for
RECORDING
EQUIPMENT

Harvey has the NEW Rek-O-Kut developments. a The NEW "Master-Pro" overhead mechanism with a *mechanical spiraling device*. This *foolproof mechanism* enables you to cut a spiral up to 3/16" pitch with no danger of making an overcut due to the *two* over-running clutches.



MODEL M-5S with magnetic cutter..$215.00
MODEL M-5, less spiraling device..$175.00

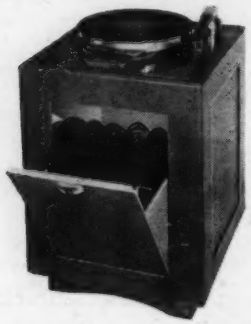
NEW Portable Case

Here is the new portable case for Rek-O-Kut recording equipment. Drilled for the Model V recording turntable, with a special drawer for storing the overhead mechanism when not in use.

MODEL P-11 Portable Case.....$ 59.00
MODEL V Standard Turntable.....$165.45
V-DELUXE Turntable with Mastermatic speed shift.....$195.45

NEW Cabinet Console

Here is a cabinet console for transcriptions, designed to take the Rek-O-Kut Model G turntable, and with capacity for storing approximately 100 16-inch records. It has four leveling legs and a unique method of mounting to reduce rumble.



MODEL C-7 Console Cabinet $129.00
MODEL G-2 Transcription Turntable $125.00
MODEL G-2 Deluxe with Mastermatic Speed Shift.....$155.00

NOTE: All prices FOB N.Y.C. and subject to change without notice.

Telephone: LO. 3-1800

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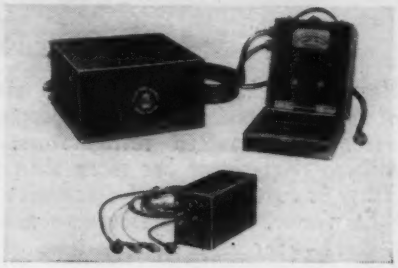
HARVEY
RADIO COMPANY INC.
103 West 43rd St., New York 18, N. Y.

York 7, N. Y. A new feature, the snap-lock, has been added to the company's standard transformer cans. This improvement allows more space inside the can, and also saves much assembly time for the user.

Traffic Radar (58)

AUTOMATIC SIGNAL DIVISION, Eastern Industries, Inc., Norwalk, Conn. Compact and portable equipment weighing only about 45 pounds is used in traffic surveys to check car



speeds from 0 to 100 miles an hour to an accuracy of 2 miles. The device uses a microwave radar transmitter-receiver and can be employed to measure the speed of any object that has appreciable area and motion.

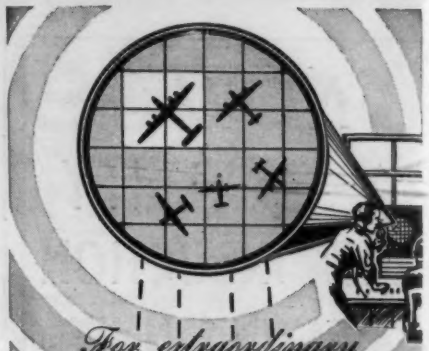
Improved Sweep Oscillator (59)

KAY ELECTRIC CO., East Orange, N. J. The Mega-Sweep oscillator, Model 2, incorporates several new features, such as carrier frequency increase to 1,000 megacycles; low

amplitude modulation while sweeping, less than 0.1 db per megacycle; a wave meter provides metering from 1 to 1,000 megacycles.

Ceilometer (60)

GENERAL ELECTRIC CO., Schenectady, N. Y. A complete ceilometer system consists of a mercury-arc projector, photoelectric detector, and a recorder that keeps a continu-



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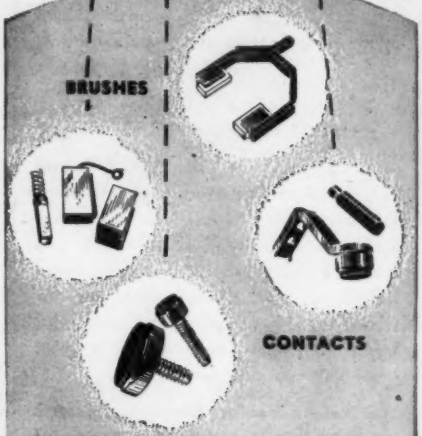

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Offering even greater ease in handling than the light-weight irons now used for difficult, intricate soldering, the Hatchet Type Iron is especially engineered and designed for operator comfort. Non-tiring even after hours of continuous use, these soldering units have all the extra advantages included in every HEXACON iron — replaceable elements of highest grade nickel-chromium wire, tips of hard-drawn copper, hexagon-shaped barrels for maximum heat dissipation during intermittent use, Underwriters' Laboratories approval, etc.

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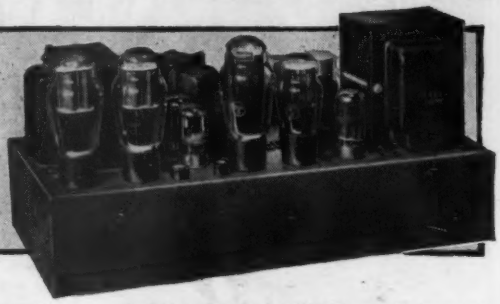
TRIODE PERFORMANCE

The superiority of a triode amplifier is most apparent in the final test... listening



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★Interstage transformer insures good push-pull balance.

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Designed by LINCOLN WALSH

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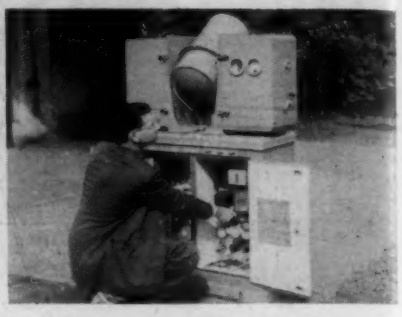

ous record of cloud variations. In practice, a pulsed light beam is cast vertically into the sky. The detector located about 1,000 feet from the projector and tuned to the same frequency as the light pulses, measures light scatter from the clouds.

•

Volt-Ohm-Milliammeter (61)

WESTON ELECTRICAL INSTRUMENT Corp., Newark 11, N. J. The new Electronic Analyzer, model 769, comprises a stable high frequency vacuum tube voltmeter for frequencies up to 300 megacycles in the range of 3 to 120 volts. A special

d-c probe containing a 5-megohm resistor is furnished for measuring d-c potentials with a minimum insertion effect. Resistance to 200,000 ohms and current up to 600 milliamperes can also be measured.

Literature

(62)

Export Catalog. British Radio Component Manufacturers' Federation, 22 Surrey St., London, W. C. 2, England. A comprehensive guide to the British radio component industry is the 184-page volume issued for distribution among overseas customers. The text, in

It's a fact! Figuring the yearly salary of a top-flight executive at around $15,000, this screw could actually buy two of them and have some change left over. Because this screw saves more than $32,800 every year for a prominent parts manufacturer (name on request) who brought his problem to our Engineering Department. Our research resulted in this screw, and the screw resulted in the saving. Perhaps we couldn't save as much as that for you, but it would be worth a three-cent stamp to find out.

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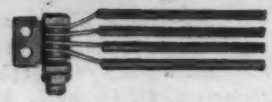

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BRADLEY LABORATORIES, INC.

82 Meadow St. New Haven 10, Conn.

English, French and Spanish is followed by a classified index according to products.

(63)

Technical Bulletin. Calco Chemical Division, American Cyanamid Co., Bound Brook, N. J. Bulletin No. 778 deals with the importance of the adjustment of pH of wool fabrics, yarn or raw stock prior to dyeing. Copies may be had by writing the company.

(64)

Control Components. American Relay and Controls, Inc., 2555 Diversey Ave., Chicago 47, Inn. A 4-page 2-color brochure is now ready showing the line of relays, switches, and leaf-spring combinations that find their way into electronic equipment.

(65)

Plastic Knobs. Kurz-Kasch, Inc., 1424 So. Broadway, Dayton 1, Ohio. A 12-page booklet describes in detail the latest in standard radio and instrument plastic knobs and control balls. Copies are now available.

(66)

Receiving Tubes. Radio Corp. of America, Harrison, N. J. Application Note 118 estimates the input admittance of receiving tubes. Values of short-circuit input conductance and capacitance for a number of r-f pentodes at frequencies of 50 to 125 mc are given.

(67)

Mica Capacitors. Aerovox Corp., New Bedford, Mass., recently issued inserts 30A and 30B showing engineering details of two new mica capacitors. Type 1690 is designed for use in uhf circuits and is ideal for aircraft application. Type 1780 handles up to 2,000 kva, exceptional for its size.

(68)

Instruments. North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y. Form No. R-1066 is a 2-page ready reference chart covering the basic characteristics of fifteen industrial laboratory instruments, with a diagram accom-

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CARRIES AM, FM and TV ANTENNAS ALL ON THE SAME MAST

Increase your radio sales by bringing home-like reception to any AM, FM and TV set in your showroom . . . eliminating all interference and bothersome noises.

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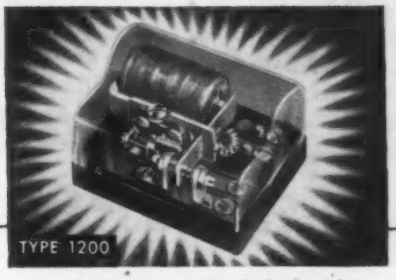

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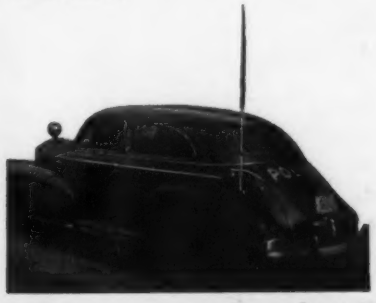

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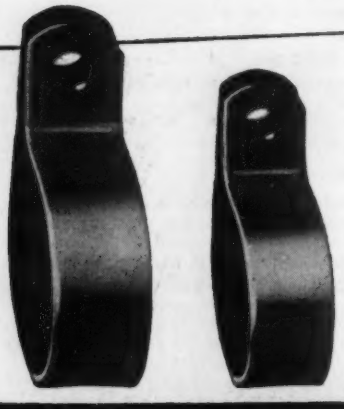

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(69)
Facsimile. Alden Products Co., 117 N. Main St., Brockton 64AF, Mass. An interesting catalog, in the form of a file of reprints, describes the background as well as the latest equipment in the field of facsimile for the home, business and communications in general.

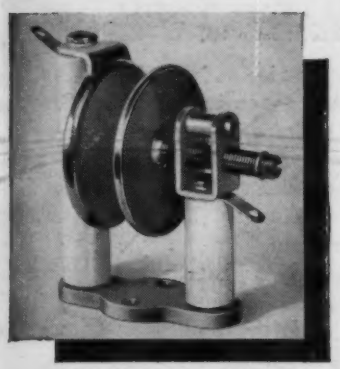
(70)
Electrical Contacts. Alloymet Mfg. Corp., 3 Grand St. Extension, Brooklyn 11, N. Y. Monthly data sheets are especially prepared to aid research and development engineers with the proper selection of electrical contact materials for specific circuit applications.

(71)
Marine Communications. Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y. The Western Electric 248A furnishes powerful, dependable, radiotelephone communication on the high seas. A complete description is found in bulletin T2376.

(72)
Cathode Press. Machlett Laboratories Inc., Springdale, Conn. This quarterly publication reports news of interest to the electronic industry at large, the development of new products, improvement of current models and their application. Copies are mailed free of charge on request.

(73)
Antennas. Premax Products, Division of Chisholm-Ryder Co., Inc., Niagara Falls, N. Y. Six pages cover the chief features of f-m and television antennas. Included are dimension charts and drawings to aid in installation.

Tubes. Radio Corp. of America, Harrison, N. J. A 16-page pamphlet (CRPS-102) is now available at ten cents a copy. It is crammed with useful technical information on 113 types of phototubes, c-r



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NEUTRALIZING CONDENSER

The improved design of the NZ-10 features smooth micrometer capacity adjustment and positive locking. Suitable for either single ended or push pull stages the NZ-10 has particular application in high frequency circuits where very fine capacity adjustment is required.

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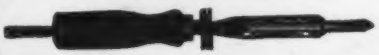

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The free-running action of the PAMARCO tension practically eliminates defective coils. Their compact size permits more simultaneous coil winds on *any* machine. Operator makes all adjustments for any gauge wire with simple thumbscrew.

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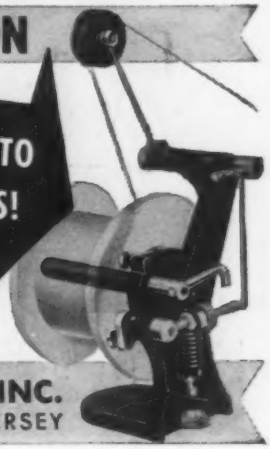


PAPER MACHINERY & RESEARCH, INC.

1014 OAK STREET • ROSELLE, NEW JERSEY

2100° F with JELLIFF RESISTANCE WIRE

FOR RELIABLE HEATING ELEMENTS and RESISTORS

Even the devil himself could not withstand the extreme temperatures to which Jelliff resistance wires are subjected. Constant research, application study and controlled production assure you fine quality products of superior performance and long life.

Jelliff resistance alloys are used extensively for industrial, radio and electronic equipment; domestic appliances; instruments; transportation apparatus and materials handling equipment.

For specific engineering data applying to your problem, refer to the new and complete 56 page Jelliff Resistance Alloys Catalog.

Write Dept. L201 for Catalog No. 46

• LEKTROMESH • RESISTANCE WIRE • FILTERS • STRAINERS • WIRE CLOTH • DIPPING BASKETS • WIRE MESH PARTS •

The C. O. JELLIFF MANUFACTURING CORPORATION

SOUTHPORT, CONN.

WIRE PRODUCTS Jelliff SINCE 1880

tubes, and special tubes. The more important types are illustrated.

Tube Registry

The information furnished by the RMA Data Bureau has been abridged and only the more significant dimensions are given.

Type 6AS6G

Pentode voltage amplifier, heater type, integral glass envelope-base; T-5½ bulb, miniature 7-pin button base; maximum bulb temperature 120 C. Maximum power output, 1.7 watts.

E_f = 6.3 v
I_f = 0.175 amp
C_{in} = 3.9 μμf
C_{out} = 3.0 μμf
$_eC_p$ = 0.01 μμf

Typical Operation

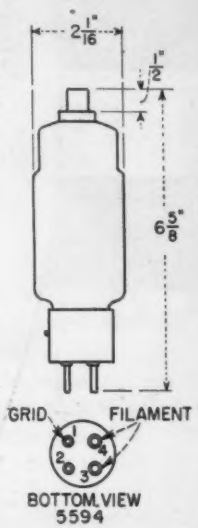
$E_b = E_{c2}$ = 120 v
I_b = 5.2 ma
E_{c3} = 0 v
I_{c2} = 3.5 ma
E_{c1} = −2 v
g_m = 3,200 μmbos

6AS6G

Type 5594

Triode xenon-filled thyratron, filament type; deionization time, approximately 1 millisecond; filament heating time, 5 seconds; temperature range −75 to −90 C.

E_f = 2.5 v
I_f = 5 amp
E_{drop} = 10 v



Control (referred to filament center tap)

E_c (E_b = 2,500 v) = −8 v
E_c (E_b = 100 v) = −2.25 v
Critical E_b at 1,000 v = 6.5 v

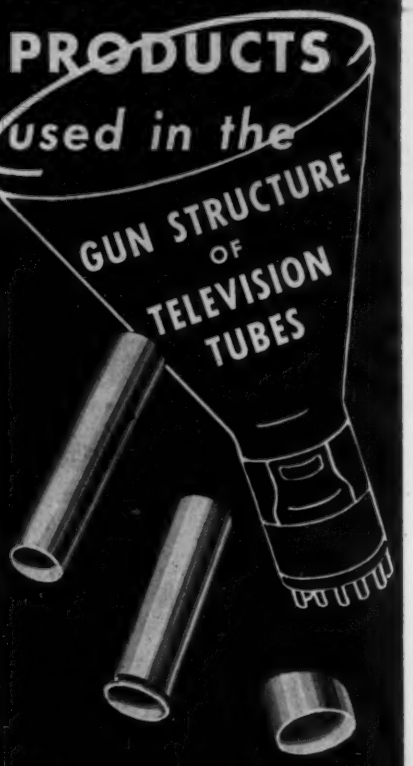
Maximum Ratings (to 500 cps)

E_{inv} = 5 kv
I_b = 2 amp (peak)
E_b = 2.5 kv
I_b = 0.5 amp (average 30 seconds)

SUPERIOR ELECTRONIC PRODUCTS

used in the

GUN STRUCTURE OF TELEVISION TUBES



ANODE AND GRID CYLINDERS—

Straight cut, angle cut or rolled edge *Tubing* produced to very close tolerances.

DISC CATHODE ASSEMBLY—

Precision made and laboratory controlled to assure correct emission and cut-off characteristics.

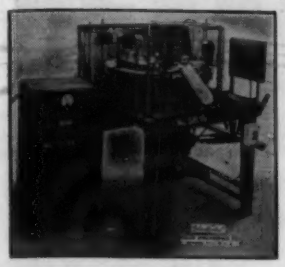
The expanding television industry has turned to Superior's Electronic Division for the *conception* and *production* of these vital parts within the television tube.

THE BIGGER NAME IN SMALL TUBING *Superior* TUBE COMPANY

ELECTRONIC DIVISION
2500 GERMANTOWN AVENUE
NORRISTOWN, PENNA.

ELECTRICAL & ELECTRONIC EQUIPMENT

ELECTRONIC TUBE EQUIPMENT



24 HEAD RADIO TUBE EXHAUSTING MACHINE

●

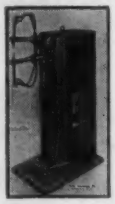
We Make Complete Equipment For The Manufacture Of Incandescent Lamps Radio and Electronic Tubes.

TRANSFORMERS OF ALL TYPES

For LIGHTING POWER FURNACES PHASE CHANGING DISTRIBUTION ETC.

●

Air, Oil, or Water Cooled



Sizes ¼ To 250 KVA

SPOT WELDERS

OF ALL TYPES
FOR ALL PURPOSES
SIZES ¼ to 250 KVA

Butt Welders - Gun Welders
Arc Welders
Neon Sign Units
Fluorescent Tube
Manufacturing Equipment

CHAS. EISLER

EISLER ENGINEERING CO., INC.

751 So. 13th St. (Near Avon Ave.), Newark 3, N. J.

SPECIAL OFFER

RUBYFLUID

SOLDERING FLUX

An opportunity for you to learn the advantages of famous Rubyfluid Soldering Flux. Special offer includes 1 pt. of liquid, ½ lb. paste flux and helpful booket, "How to Solder"—all three for only $1.

Send your $1 today to . . .

RUBY CHEMICAL CO.

59 McDowell St.
Columbus, Ohio

Rubyfluid

Cetron MERCURY and GASFILLED

GRID CONTROL RECTIFIERS

LONG LIFE
HIGH EFFICIENCY
QUICK START

These inexpensive rectifier tubes are designed for industrial applications such as welding control, motor control, etc., at ambient temperature limits of approximately −40° to +80° C.

RATINGS*	CE-311**	CE-320	CE-322
DC Ampere output			
Max. Average Continuous	1.5	2.5	6.4
• Oscillograph Peak	6.0	30.0	80.0
Peak Inverse Volts (Max. Inst.)	1000	1250	1500
Filament Volts	2.5	2.5	2.5
Amperes	6±1	9±2	20±3
Approx. Heating Time (in sec.)	15	30	45

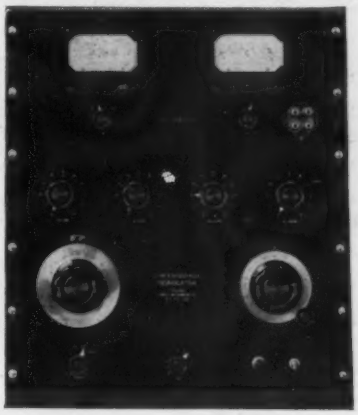
* Condensed mercury temperature 40 — 70° C.
** Also available: modified types CE-323A and CE-393A.

For technical data and special information write to

CONTINENTAL ELECTRIC CO.

Geneva, Illinois

101



FREED *Low Frequency* "Q" INDICATOR

Type No. 1030. Frequency range 20 to 200,000 cycles, "Q" range from .5 to 500. "Q" of inductors measured with up to 50 volts across the coil.

INDISPENSABLE INSTRUMENT FOR MEASUREMENT OF:—

"Q" and inductance of coils
"Q" and capacitance of capacitors Dielectric losses and power factor of insulating materials

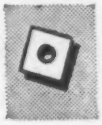
FREED TRANSFORMER CO., INC.
Instruments Division
72 Spring St. New York 12, N. Y.

FOR MOST DEPENDABLE SERVICE *To your Specifications* QUADRIGA

QUALITY WASHERS

Make sure with washer *precision* matching your engineering. Half a century of experience. Facilities for quick production, any quantity, small or large. Also wire terminals, and SMALL STAMPINGS, any design. Without obligation advise us of your needs for prompt estimate. Ask for QUADRIGA Catalog.

The Quadriga Manufacturing Co.
221-A W. GRAND AVE.,
CHICAGO 10, ILLINOIS



from FLAT SURFACES TO INTRICATE SHAPES with the New DI-ACRO BRAKE

- ROK-LOK—new sensitive material clamp increases accuracy
- DOUBLE-EDGED FORMING BLADE allows close reverse bends
- NEW PRECISION STOPS accurately control angularity of bends

This versatile metal forming machine was developed for use in model shops, experimental laboratories and production departments where it often replaces dies for all types of precision forming operations. Di-Acro Brakes will form a great variety of materials including bronze, stainless steel, aluminum and bi-metals.

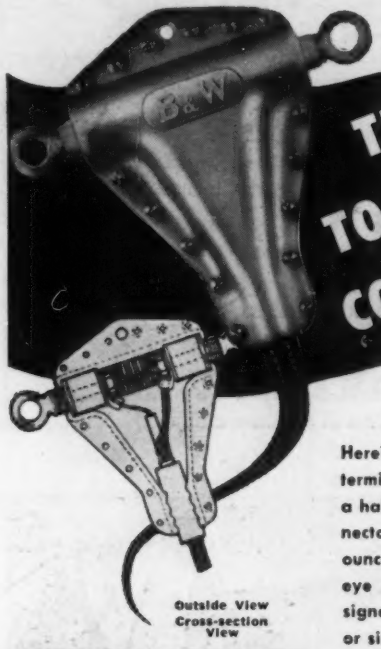
WRITE FOR CATALOG. New edition of 40-page Di-Acro Catalog contains detailed information on all Di-Acro Brakes, Shears, and Benders and illustrates how these precision machines can be used individually or cooperatively for "DIE-LESS DUPLICATING".

◀ DI-ACRO is Pronounced "Die-Ack-Ro"

DI-ACRO PRECISION MACHINES DIE-LESS DUPLICATING

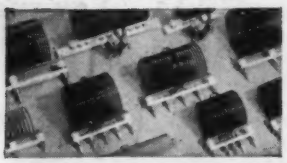
O'NEIL-IRWIN MFG. CO.

321 8TH AVE., LAKE CITY, MINNESOTA



THE HANDY WAY TO MAKE CO-AX CABLE CONNECTIONS—*RIGHT!*

Outside View
Cross-section View



A light-weight water-tight assembly

Here's the quick, easy and FULLY DEPENDABLE way of terminating a coaxial line where it joins the center of a half-wave doublet antenna—the B & W CC-50 Connector. Made of cast aluminum and weighs only 12 ounces. Steatite insulation. Forged zinc dipped steel eye bolts provide handy soldering connections. Designed for all coaxial cables such as RG11/U, RG34/U or similar types with either single or twin leads. Makes an absolutely watertight seal. Ideal for use as center insulator for a half-wave doublet.

AIR INDUCTOR HEADQUARTERS

B & W "Air-Wound" Inductors come in types, shapes and sizes for almost every coil application.

B&W

BARKER & WILLIAMSON
237 Fairfield Avenue, Upper Darby, Pa.

Export—Royal National Co.

(continued from p 146)

ness session of the 23rd annual RMA convention at the Stevens Hotel, Chicago.

New president is Max F. Balcom, vice-president and treasurer of Sylvania Electric Products Inc., of Emporium, Pa., succeeding Ray C. Cosgrove, general manager of the Crosley Division, Cincinnati, who concluded three years of service as RMA head.

Treasurer Leslie F. Muter, of the Muter Co., Chicago, was reelected for his thirteenth term. The Board of Directors also elected two new vice-presidents, reelected three others. Four new directors were added to the board, and eleven directors were reelected. Two new division chairmen were elected by their respective divisions, and three division chairmen were reelected. Reappointed director of the RMA Engineering Department, Dr. W. R. G. Baker, vice-president of General Electric Co., Syracuse, N. Y., remains a member of the Board of Directors.

Among the new industry services authorized by the newly organized RMA Board of Directors was the expansion and modernization of RMA statistical services to cover the movement of radio and television receivers through distribution channels and their retail sales. A special committee was appointed by president Balcom to set up the machinery by which a monthly panel survey of the movement and sale of radio sets can be made. The board appropriated $10,000 to fi-

New RMA head, Max F. Balcom of Emporium, Pennsylvania, has been active in association affairs for the past 12 years

NEW UNDERWRITER'S APPROVED
125 VOLT—CANDELABRA
BAYONET SOCKET ASSEMBLIES

NOW you can get fine *Underwriter's Approved* candelabra Dial Light Socket Assemblies by DRAKE! The No. 900 series is designed for radio use, and the No. A900 series for general use. Both are double contact, candelabra, bayonet Assemblies housing 115V household type lamps, available from 5 to 25 watts. They are U.L. approved for 75W-125V service. Can also be used with 6V automotive lamps.

The bayonet type eliminates vibration-loosened lamps and requires less space than screw type. Can be supplied with any type mounting bracket. Lead-in wires from 2½" to 60". Made to traditional DRAKE standards of precision and rugged dependability. Check with our engineers on your requirements, *today!*

ASK FOR OUR NEW CATALOG • NO OBLIGATION!

DRAKE

Socket and Jewel LIGHT ASSEMBLIES

DRAKE
MANUFACTURING CO.
1713 W. HUBBARD ST., CHICAGO 22

nance the establishment of this new service.

The directors also voted to expand the RMA headquarters staff to provide additional administrative services for transmitter and parts manufacturers.

Uniform f-m receiver dial marking, using megacycle listings instead of FCC channel numbers, was recommended for the RMA Set Division by Chairman Paul Galvin. This recommendation concurs with that of the RMA Engineering Department.

An appropriation of $20,000 for the preparation of National Radio Week promotion material was made by the retiring Board of Directors.

Publication of a report on recommended basic standards for school sound recording and playback equipment was made by the board upon recommendation of the School Equipment Committee. This published report, prepared in cooperation with the U. S. Office of Education, will supplement the "School Sound Systems" brochure published by the RMA last fall and distributed to schools and colleges by the Office of Education.

An intensification of the RMA "Radio-in-Every-Room" set sales promotion campaign was reported to the Board of Directors and the Advertising Committee. The committee approved a slide film "Let's Get Personal", which will be available to retail trade groups.

New AIEE Officers

BLAKE D. HULL, chief engineer of Southwestern Bell Telephone Co., St. Louis, Mo., has been elected president of AIEE for the year beginning August 1, 1947, as announced at the annual meeting of the Institute held in Montreal. The other officers elected were: Vice-Presidents: G. W. Bower, Haddonfield, N. J., J. H. Berry, Norfolk, Va., I. M. Ellestad, Omaha, Nebr., D. I. Cone, San Francisco, Calif., D. G. Geiger, Toronto, Ontario; Directors: W. L. Everitt, Urbana, Ill., A. C. Monteith, East Pittsburgh, Pa., Elgin B. Robertson, Dallas, Tex.; Treasurer, W. I. Slichter, New York, N. Y. (re-election).

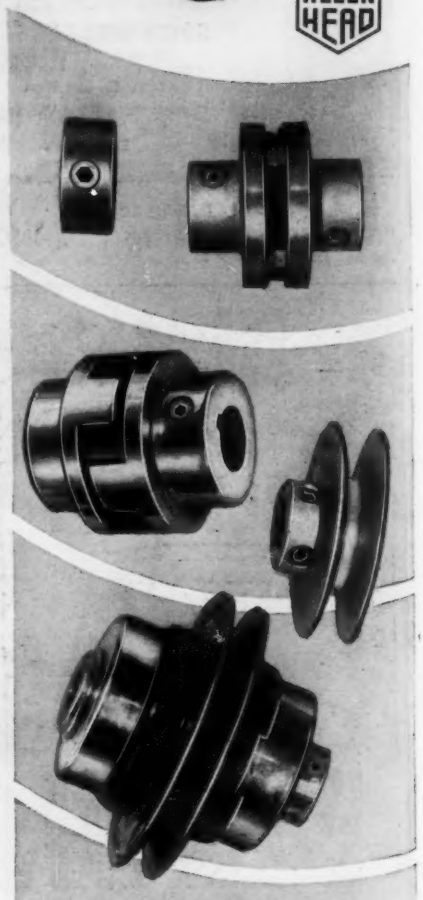
The annual report of the Board of

ALLEN

HEX-SOCKET SET SCREW

Applications

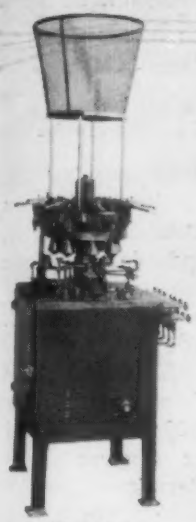
ALLEN HEAD



In collars, pulleys, couplings of all types, ALLEN Hex-socket Screws *grip* with never a slip. Formed and threaded by Allen-perfected processes, applied selectively to produce the strongest precision screw in a given size. High Class 3 fit standard; Class 4 on special order. Call your local Allen Distributor for samples or demonstration.

THE ALLEN MFG. COMPANY
HARTFORD, CONNECTICUT, U. S. A.

BAACH-INTERNATIONAL



EIGHT HEAD HOT CUT FLARE MACHINE

•

Automatic throughout.

Can be synchronized with automatic Stem machine.

Cuts off and flares in one operation.

Production 1250 flares per hour. For miniature flares, fluorescent starters, standard size lamps, fluorescent and radio tubes.

RANGE OF MACHINE

Glass tubing
27 to 45 gauge

Length of flares
5 mm. to 80 mm.

Forms flares up to 47 mm. diam.

Net weight, 960 lbs.
Gross weight 1450 lbs.

Dimensions
24"x24"x72" high

INTERNATIONAL MACHINE WORKS

Manufacturers of High Vacuum Pumps, Automatic Machinery for Incandescent Lamps, Electronic Tubes since 1916.

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NORTH BERGEN, N. J., U. S. A.

Tel. UNion 3-7412
Cable Address "Intermach" North Bergen, N. J.

GRACOIL

"One Good Turn – or a Million"

★ Here, in expanded plant facilities, GRACOIL Coils and Transformers are expertly designed and built to exact specifications. Plan your next product with GRACOILS.

THE GRAMER COMPANY

Established in 1935
Electrical Coils and Transformers
2736 N. PULASKI RD., CHICAGO 39, ILL. U. S. A.

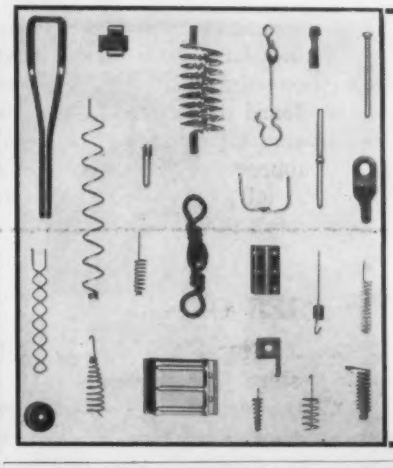
Crystals for the Critical

IF6 CRYSTAL FILTER WITH HIGHER Q

The "Stabilized" IF6 filter crystal has become standard with many of America's leading receiver manufacturers—and for good reason, too. Our "Stabilizing" process materially raises the Q—permits sharp signal discrimination. The holder has lower capacity and the crystal is free from spurious frequencies within +0 —10 KC of operating frequency. Normally supplied in 455 KC, but can also be supplied in a wide frequency range.

Catalog On Request Or Write Us About Your Crystal Problems

The JAMES KNIGHTS CO.
SANDWICH, ILLINOIS



SMALL PARTS

Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to ⅛-inch. Any length up to 12 feet.

LUXON fishing tackle accessories.

Inquiries will receive prompt attention.

ART WIRE AND STAMPING CO.
227 High St. Newark 2, N. J.

JUST ANOTHER TRANSFORMER?
OR GUARANTEED
TERMINAL PERFORMANCE!

TRANSFORMERS - COILS

Any or all Types built to individual specifications
RESEARCH-DESIGN-PRODUCTION
Single Items or Quantity Production
GOSLIN ELECTRIC AND MANUFACTURING CO.
2921 WEST OLIVE STREET BURBANK, CALIFORNIA

SUSTAINED ACCURACY

OVER 1,000,000 CYCLES AT 30 rpm

(Single units or ganged as illustrated)

NEW! Fairchild's *new* Linear single-turn Potentiometers are small precision instruments—that out-perform conventional potentiometers. Sustained accuracy and long service are assured by Fairchild construction that includes contacts composed of gold, platinum and silver alloys. Performance includes a guaranteed linearity accurate to 0.15% (2" size); 0.1% (3" size) . . . less than one ounce-inch torque and 4 or 5 watt power dissipation . . . 100 to 100,000 ohm resistance range . . . single or ganged flexibility . . . 351° and 355° angles of electrical rotation. Available in 2" and 3" sizes. Engineered for quantity production. For further information address: Dept. 'E', 88-06 Van Wyck Boulevard, Jamaica 1, New York.

Fairchild CAMERA AND INSTRUMENT CORPORATION

CUTS RECORDS UP TO 10" DIAMETER

PLAYS RECORDS UP TO 12"

ONE BUTTON CONTROLS SPEED 78 or 33 1/3 R.P.M.

JUST LOWER CUTTING ARM TO START RECORDING

Smooth Power . . . FOR HOME RECORDING

Your customers will be delighted with the high-quality home recordings they can make on this GI Dual-Speed Home Recording and Phonograph Assembly. Equipped with ample *Smooth Power* for recording or reproducing, it's simple as ABC to operate. It's sturdily built to stand up under hard use . . . and it's remarkably low-priced for volume sales.

Send for details on this fine unit, and for complete information on the complete *Smooth Power* line of Phonomotors, Recorders and Combination Record-Changer Recorders.

THE GENERAL INDUSTRIES CO.

DEPT. ME • ELYRIA, OHIO

Directors, presented at the meeting, showed a total membership on April 30, 1947, of 26,478.

Tube Standards

FOUR NEW standards covering the design and construction of electron tubes have been published as joint RMA-NEMA standards and are available from National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N. Y.

Standards for Electron Tube Bases, Caps, and Terminals; NEMA Publication No. 500; dimensional characteristics for electron tube bases, caps and terminals; letter and number designations for bases, caps, and such other parts as mate with sockets or connector attachments; 19 pages, $1.50.

Standards for Dimensional Characteristics for Water-cooled Transmitting Tubes; Publication No. 501; 4 pages, $.25.

Standards for Dimensional Characteristics of Electron Tubes; Publication No. 502; outline dimensions of electron tubes, such as acorn types, miniature types, metal types, metal-enclosed glass types, locking-in glass types, and other various glass types, classified by group numbers; 10 pages, $.80.

Standards for Gauges for Electron Tubes; Publication No. 503; specified dimensions and tolerances for ring gages for checking maximum and minimum base and sleeve diameters. It also covers alignment gages used to govern the spacing and alignment of base contacts and such other factors as may be important to interchangeability; 5 pages, $.50.

Relay Manufacturers Form Association

THE NATIONAL ASSOCIATION OF RELAY MANUFACTURERS was formally organized in Chicago in May when representatives of leading relay manufacturers from all parts of the country drew up a charter of aims and elected Ralph T. Brengle, of Potter & Brumfield Sales Company, Chicago, as the first president. Also named to the executive panel at the time were: C. P. Clare, of

★STAR

VITAL AIDS

FOR THE

Manufacturers of 7-pin and 9-pin miniature tube—radios and equipment

#JE-9 (9-pin)—#JE-10 (7-pin)—Star Miniature socket wiring plugs for accurate alignment of miniature socket contacts during wiring. Precision cast of zinc base alloy—pins of stainless steel.

#JE-15 (9-pin)—#JE-13 (7-pin)—Star Miniature tube pin straighteners (with stainless steel insert) to obtain a perfect fit when the tube is placed in the equipment.

Scientifically designed—Precision made

READY FOR IMMEDIATE DELIVERY IN ANY QUANTITIES

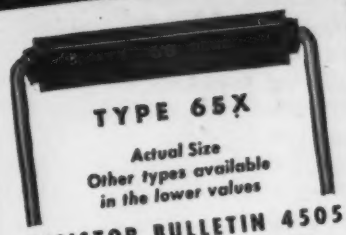
STAR EXPANSION PRODUCTS CO. INC.

147 Cedar St. New York 6, N. Y.

MOLDED

S.S.White RESISTORS

The "All-Weather" Resistors



TYPE 65X

Actual Size
Other types available in the lower values

RESISTOR BULLETIN 4505 GIVES FULL DETAILS...

It shows illustrations of the different types of S. S. White Molded Resistors and gives details about construction, dimensions, etc. A copy, with Price List will be mailed on request. Write for it—today.

- Noiseless in operation
- Strong and durable
- Good performance in all climates

STANDARD RANGE

1000 ohms to 10 megohms

• NOISE TESTED •

At slight additional cost, resistors in the Standard Range are supplied with each resistor noise tested to the following standard: "For the complete audio frequency range, resistor shall have less noise than corresponds to a change of resistance of 1 part in 1,000,000."

HIGH VALUES

15 to 1,000,000 megohms

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO.

DEPT. R, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

FINE INDICATING LIGHTS SINCE 1930

KIRKLAND PILOT·LIGHTS

ARE DISTRIBUTED NATIONALLY BY

GENERAL ELECTRIC
SUPPLY CORPORATION.

Gray·bar
ELECTRIC COMPANY, INC.

WESTINGHOUSE
ELECTRIC SUPPLY COMPANY

OVER 300 OFFICES...COAST TO COAST

No. 600 Unit

One of Many Kirkland Units

Underwriters' Approved heavy duty unit for 120V service. S6 bulb. Single hole mounting in 1-3/8" diameter hole. Overall length of threaded area 1-7/16". Also ideal for building Lamp Annunciators (furnished with flat lens for letters or numbers). *Write for Catalogue.*

THE H. R. KIRKLAND CO.
Morristown, N. J.

TIMER & CONTACTOR

FOR	
LOW CAPACITY & LABORATORY	220 V 5 KVA
SPOT WELDERS	110 V 3 KVA

Timer Graduated from 2-80 Cycles in Two Ranges.
Accurate to ± 2% at Any Setting.
Time Delay & Thermal Overload.

DELIVERY 3 WEEKS **PRICE $350**

SEQUENCE TIMING & HEAT CONTROL SUPPLIED ON REQUEST

GBH PRODUCTS CO.
180 DAVISON ST.
LYNBROOK, N. Y.

Preferred

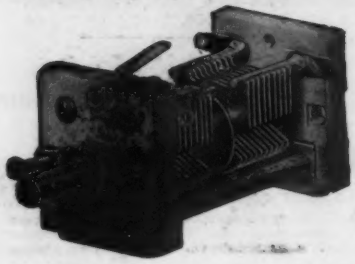
as a source of precision-made WASHERS and STAMPINGS manufactured to your specifications

CUP WASHERS for Binding Screws

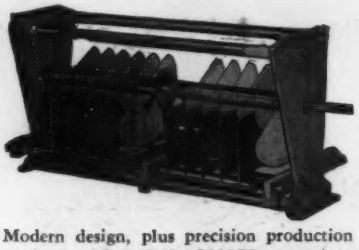
WHITEHEAD STAMPING CO.

1691 W. Lafayette Blvd. Detroit 16, Michigan

The BUD
CONDENSER LINE
covers *all* your needs
for *quality* condensers



The TINY MITE condensers include a complete line of padders and single and dual section tuning condensers. When space or weight are limiting factors . . . these condensers will "fit the bill".



Modern design, plus precision production methods makes BUD GIANT transmitter condensers the choice of critical engineers for use in such applications as broadcast transmitters, high-powered trans-oceanic communication equipment and many other highly specialized electronic devices.

And this isn't all! Have your local distributor show you the complete BUD Condenser Line and see for yourself its many exclusive advantages!

BUD Can Supply All Your Needs! . . .

. . . with the latest types of equipment including: condensers—chokes—coils—insulators—plugs—jacks— switches— dials— test leads—jewel lights and a complete line of ultra-modern cabinets and chassis.

BUD
BUD RADIO, INC.
CLEVELAND 3, OHIO

C. P. Clare and Company, Chicago, vice-president; and J. J. Rowell, of Guardian Electric Manufacturing Company, Chicago, secretary-treasurer.

The initial goal of the organization is the establishment of a code of standards by which electrical relays may be tested and rated so that buyers do not receive widely differing relays from two manufacturers even though published specifications in the past have been identical. Other mutual problems to which solutions will be sought are material specifications, general characteristics, classifications, government and underwriters' specifications, and more effective metallurgical research for improvement in performance and durability of products.

The relay industry comprises some 80 manufacturers including those who build relays in addition to other types of electrical equipment. Latest estimates show that the total annual business of the industry amounts to more than $100,000,000.

Firms representing the industry at the organization meeting were: Advance Electric and Relay Co., Los Angeles; Automatic Electric Manufacturing Co., Mankato, Minn.; C. P. Clare and Co., Chicago; Control Corp., Minneapolis; Guardian Electric Manufacturing Co., Chicago; Leach Relay Co., Los Angeles; Potter & Brumfield Manufacturing Co., Princeton, Indiana; Price Electric Corp., Frederick, Md.; Struthers-Dunn, Inc., Philadelphia; Phillips Control Corp., Chicago; R. B. M. Manufacturing Co., Logansport, Indiana; and Allied Controls, New York City.

Radar Laboratory

A NEW experimental radar laboratory at Air Materiel Command headquarters, Wright Field, is constructed almost entirely from wood so as to offer a minimum of interference to radar equipment under test inside. The 100 by 200 foot structure reaches to a height of 75 feet, and is located on a hilltop affording maximum radar coverage of the Wright Field area. It is to be used for testing operation of new ground and airborne radar equipment as well as for calibrating

BRADLEY
PHOTO ELECTRIC CELLS

Reduce Production Costs

Bradley Luxtron* photocells improve control over manufacturing operations, reducing your costs. They meet the most exacting requirements. Advanced manufacturing techniques make light-actuated Bradley cells the choice all over the world.

Luxtron photocells convert light directly into electrical energy. No external source of voltage is required. Besides the housed model shown with its plug-in contacts, Bradley also offers tube socket, nut-and-bolt types and pigtail contact mountings. In addition, Luxtron unmounted cells are available in many different sizes and shapes.

*T. M. REG. U. S. PAT. OFF.

Illustrated literature, available on request, shows more models of Bradley photocells, plus a line of copper oxide and selenium rectifiers. Write for "The Bradley Line."

BRADLEY
LABORATORIES, INC.
82 Meadow St.- New Haven 10, Conn.

Specify
MYCALEX
LOW LOSS INSULATION

Where high mechanical and electrical specifications must be met.

For *Complete* Catalog and Specifying information on MYCALEX 400, K, & 410 refer to pages 84-85 in the 1947 Mid-June *BUYERS' GUIDE ISSUE OF ELECTRONICS.*

27 years of leadership in solving the most exacting high frequency insulating problems.

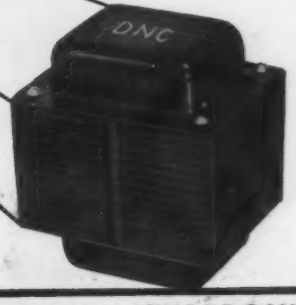
MYCALEX CORPORATION OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices: Clifton, N. J.
Executive Offices: 30 Rockefeller Plaza New York 20, N. Y.

STROMBERG-CARLSON *uses-*
DINION
Transformers and Coils

• Photo Flash Control • Instrument • Television
• Radio • Electronics and Industrial Applications
• Electrical Coil Windings



The stringent requirements of a radio of distinction call for high calibre transformers and electrical coil windings. For superior quality and production, manufacturers use Dinion Transformers and Coils.

Specialists in Difficult Designs

DINION COIL COMPANY, INC. CALEDONIA NEW YORK

It's
• *Legri S* for
• RESISTORS
Half - One - Two Watt

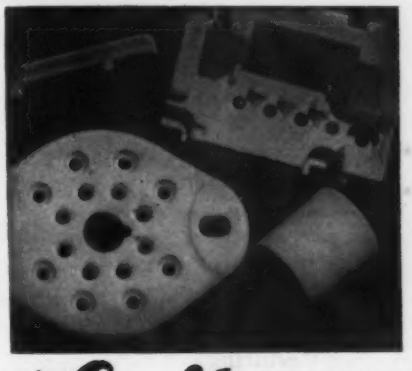
- INSULATED
- ANY TOLERANCE
- WE CALIBRATE RESISTORS within 1 and 2% Tolerance.
- ANY QUANTITY
- ANY MAKE

Immediate Delivery!

WE SHIP THE SAME DAY YOUR ORDER IS RECEIVED

Inquire Today!

LEGRI S COMPANY, Inc.
ELECTRONIC PARTS AND COMPONENTS
846-850 Amsterdam Ave.
NEW YORK 25, N. Y.
AC 2-0018



Lavite STEATITE CERAMIC

Properties and Characteristics of Our LAVITE S1-5 Steatite Ceramic Body

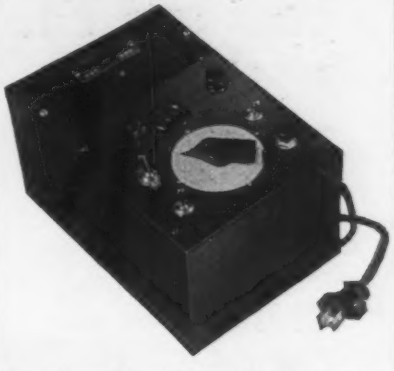
Compressive Strength	96,000	lbs. per square inch
Tensile Strength	7,200	lbs. per square inch
Fluxural Strength	10,500	lbs. per square inch
Modulus of Rupture	20,000	lbs. per square inch
Dielectric Strength	235	volts per mil
Dielectric Constant	6.42	Frequency of 1 megac/cle
Loss Factor	2.90	
Power Factor	446	
Bulk Specific Gravity	2.664%	
Density (from above gravity)	0.096	lbs. per cubic inch
Hardness (Mohr scale)	7.0	
Softening Temperature	2,350°F.	
Linear Coefficient of Expansion	8.13x10—6	
Moisture Absorption (ASTM D-116-42-A)	0.009%	

Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency application.

We will gladly supply samples for testing.

D. M. STEWARD MFG. COMPANY
Main Office & Works: Chattanooga, Tenn.
Needham, Mass. • Chicago • Los Angeles
New York • Philadelphia

PHOTOVOLT
Electronic PROCESS TIMER



An adjustable timing relay for timing periods 1/20 to 50 sec.

- **for welding, process timing, printing, control of machinery, and protection of electronic tubes**
- **for single actuation as well as sequence timing and recycling in continuous operation**
- **for AC of any frequency and for DC**

Write for Bulletin #950

PHOTOVOLT CORP.
95 Madison Ave. New York 16, N. Y.

and guided missiles, has been awarded a certificate of achievement from the U. S. Navy.

ADMIRAL CORPORATION recently opened its new assembly plant for small radios in Harvard, Ill.

SOLA ELECTRIC CO. recently moved all branches into its new plant at 4633 W. 16th St., Chicago 50, Ill.

New Sola Electric Co. plant

PYROFERRIC CO., manufacturer of powdered metal cores, is now located at its new and larger headquarters, 621 E. 216th St., New York 67, N. Y.

RAYTHEON MANUFACTURING COMPANY, Waltham, Mass., now has a Commercial Products Division, comprising the broadcast equipment division and what was formerly known as the industrial electronics division.

BITTERMAN ELECTRIC COMPANY, Brooklyn, N. Y., moved last month to its new headquarters at Saugerties, N. Y.

A. L. NELSON & CO., radio transformer manufacturer, is now owned by the Nelson Electric Corp. of Santa Monica, California.

E. F. JOHNSON COMPANY, Waseca, Minnesota, purchased the Speedx line of semi-automatic and hand keys, practice sets and buzzers from the Les Logan Company, San Francisco, California.

PERSONNEL

A. M. WIGGINS, research director of Electro-Voice, Inc., Buchanan, Michigan, has just returned from a survey of electro-acoustic developments in Germany.

SAMUEL M. THOMAS received the appointment of vice-president and general superintendent of RCA Communications, Inc., after serving as assistant chief engineer since February 10, 1947. Prior to retir-

NEW *Crystal Hand Microphone*

•HIGH PERFORMANCE At Low Cost.

THE TURNER MODEL 20X

Designed for home recording, paging system, public address, and amateur work. Unusually smooth response, exceptionally high level. Features a Metalseal crystal. Light in weight and natural to hold. Hangs on hook when not in use. Baked brown enamel finish.

CONDENSED SPECIFICATIONS

- Response: ± 5db from 50 — 7000 c.p.s.
- Level: 54db below 1 volt /dyne/sq. cm.
- Cable: 7 ft. attached, shielded.
- Dimensions: 6¼" long x 1" thick x 2⅛" wide.
- Weight: 8 oz.

Licensed under patents of the Brush Development Co.

Microphones BY TURNER

For complete information write

THE TURNER COMPANY

905 17th Street N. E. Cedar Rapids, Iowa

DEPENDABLE

MARINE CRYSTALS

Manufacturers of marine radio receivers and transmitters report thousands of R-H Marine Crystals in use without a single failure. R-H Marine Crystals provide the reliability necessary for safety at sea.

R-H Marine Crystal Units are made to the **marine radio manufacturer's** specifications, to fit the **marine radio manufacturer's** circuit.

Illustrated are RH-12 for single unit installations and RH-53 in double units for both transmitting and receiving.

REEVES-HOFFMAN Crystal Units Catalog RHC-1 lists standard crystal units complete with specifications. It also gives valuable information on how to order crystals.

REEVES-HOFFMAN CORPORATION

SALES OFFICE: 215 EAST 91 STREET, NEW YORK 28, N. Y.

PLANT: 321 CHERRY STREET, CARLISLE, PA.

CAPITOL RADIO ENGINEERING INSTITUTE

—Where the Professional Radioman Studies

Which Will Get The *Better* Job?

The Radioman Who Looks Ahead Will Get Ahead

Dont play blind man's bluff with your future! Look at the successful radioman. You'll find that he's the fellow who looked and *planned* ahead. Today, as a member of the great radio-electronic industry, you too, have opportunities that few men ever enjoyed in the past. Your future success can be assured by the plans *you* make *today*.

The radio industry is expanding so fast, that it is doubtful any radioman can truthfully say he has kept pace with all the major developments. Thousands of new men have joined the ranks of the radio industry creating new competition. New developments, create demands for more advanced technical ability. You must "re-tool" your technical knowledge in order to keep pace.

If you are wise, you will look ahead and start now to increase your technical ability with the thorough, practical technical training for which thousands of professional radiomen have enrolled with CREI since 1927. In our proved method of instruction, you learn not only "how", but "why". This is real, honest-to-goodness practical engineering training that leads to better jobs and security in the knowledge that you are capable of coping with tough problems of communications and industrial electronic equipment.

It costs you nothing to read the interesting facts. Please write today.

Veterans!
Crei Training Available Under "G. I." Bill.

MAIL COUPON FOR FREE BOOK

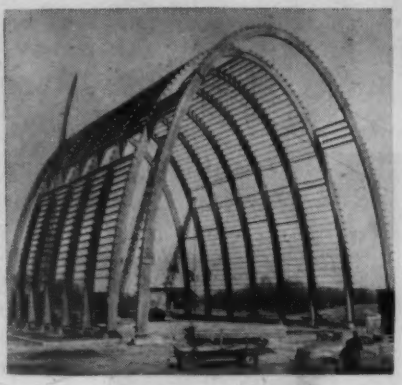
If you are a professional radioman and want to make more money, let us prove to you we have the training you need. To help us intelligently answer your inquiry—please state briefly your background of experience, education and present position.

Capitol Radio Engineering Institute
16th & Park Rd., N. W., Dept. E-8,
Washington 10, D. C.

Gentlemen: Please send me your free booklet, "CREI Training for Your Better Job in RADIO-ELECTRONICS", together with full details of your home study training. I am attaching a brief resume of my experience, education and present position.

Check ☐ Practical Radio Engineering
Course ☐ Practical Television Engineering

Name .....
Street .....
City..... Zone.... State.....
☐ I am entitled to training under the G.I. Bill



A minimum of metal is being used in construction of this low field radar laboratory at Wright Field, to permit operation of radar equipment inside with all the comfort and efficiency of a heated lab

radar equipment in nearby aircraft.

Facilities of the laboratory will also be used in other aircraft calibrations, including speed measurement, determination of radius of turn at various speeds, and analysis of traffic procedures in conjunction with instrument approach systems.

Index to Wartime Reports

A COMPREHENSIVE index guide to the tens of thousands of reports on wartime technological developments in the United States, Germany, and other countries has been prepared by the Office of Technical Services, Department of Commerce.

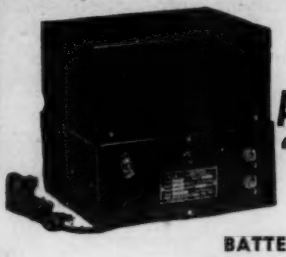
The index is intended for use with *Bibliography of Scientific and Industrial Reports*, published weekly since January 1946 and containing a brief abstract of each report acquired by OTS.

The new *Index to the Bibliography of Scientific and Industrial Reports*, available from the Superintendent of Documents at 50¢, contains about 45,000 cross-reference entries classified under major subject headings, including electronics. With the index and a file of the *Bibliography* at hand, a researcher may readily determine the number of reports available from OTS in a special subject field and examine the abstracts.

BUSINESS NEWS

YARDENEY ENGINEERING COMPANY, New York, now working on remote control devices, pilotless aircraft

CURRENT CONVERSION WITH ATR QUALITY PRODUCTS



ATR "A"

BATTERY ELIMINATORS
For Demonstrating and Testing Auto Radios

New Models . . . Designed for Testing D.C. Electrical Apparatus on Regular A.C. lines. Equipped with Full-Wave Dry Disc Type Rectifier, Assuring Noiseless, Interference-Free Operation and Extreme Long Life and Reliability.

- Eliminates Storage Batteries and Battery Chargers.
- Operates the Equipment at Maximum Efficiency.
- Fully Automatic and Fool-Proof.
- Type 60-ELIA . . . Rated Output 6.3 Volts at 6.5 Amperes.
  Net Price $22.80
- Type 120C—ELIO . . . Rated Output 6.3 Volts at 14 Amperes.
  Net Price $37.20

ATR AUTO RADIO VIBRATORS

Designed for Use in Standard Vibrator-Operated Auto Radio Receivers. Built with Precision Construction for Longer Lasting Life. Prices are app. 15% lower.

ATR STANDARD AND HEAVY DUTY INVERTERS

For Inverting D. C. to A. C.

Specially Designed for Operating A.C. Radios, Television Sets, Amplifiers, Address Systems, and Radio Test Equipment from D.C. Voltages in Vehicles, Ships, Trains, Planes and in D.C. Districts.

Write for New ATR Catalog—Today!

AMERICAN TELEVISION AND RADIO CO.
Quality Products Since 1931
SAINT PAUL 1, MINNESOTA — U. S. A.

Water Mill Laboratories of The Western Union Telegraph Co.

C. W. HENDERSON, former standards engineer at RCA, has joined Clarostat Mfg. Co., Inc. as sales engineer in the Philadelphia area.

DENNISTOUN W. VER PLANCK, professor of electrical engineering at Carnegie Institute of Technology, has been named head of the department of mechanical engineering and professor in that department. For his work during the war in degaussing of ships he was an honorary member, Order of the British Empire, and received the Commendation and Ribbon Bar from the Secretary of the Navy.

W. AUSTIN ELLMORE has been appointed chief engineer and sales manager of Crescent Industries Inc. Formerly vice-president in charge of engineering and sales at Utah Radio, he is active on seven RMA committees.

EDWIN G. SCHNEIDER, formerly assistant to the president for research at Stevens Institute of Technology, was appointed director of research on controlled flight, including flight at supersonic speeds at the Institute. He was research physicist for both Farnsworth Television Co. and Philco in turn before joining Stevens Institute in 1938. During the war, at MIT Radiation Lab, he led a group which directed the development of ground radar for control of aircraft and for early warning. From 1944 to October 1945 he was expert consultant to the Office of the Secretary of War.

E. G. Schneider

J. D. Woodward

JOHN D. WOODWARD, promoted to manager of the RCA Aviation Equipment Engineering Group, will supervise the development and engineering of aviation radio communication and navigation equipment

THE NEW ELECTRONIC AMPLICALL INTERCOMMUNICATION

America's Finest Business Communication Systems

Dramatically different in its impressive plastic styling, definitely advanced in functional design . . . that's the New AMPLICALL! Apart from exceptional fidelity of speech reproduction, the New AMPLICALL incorporates a number of exclusive advantages in operation and installation which sets it apart as a significant design achievement in the intercommunication field. New AMPLICALL Systems are available to meet every conceivable business communication requirement. You are invited to write for full details covering America's Finest Intercommunication Systems.

Featuring:

"Busy" Signal—visual type using neon bulb indicator

Plug-In Masters for quick exchange or transfer

Illuminated volume control to indicate "on"

Balanced Lines—eliminates need for shielded lines to Remote stations

Handset—optional for private conversation

THE RAULAND CORPORATION
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RADIO • RADAR • SOUND • COMMUNICATIONS • TELEVISION

another pair of . . .

COSMALITE* applications

These spirally laminated paper base Phenolic Tubes are of two types . . .

#96 COSMALITE for coil forms in all standard and broadcast receiving sets.

SLF COSMALITE for permeability tuners.

LOW COSTS QUICK DELIVERIES

Ask also about our spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

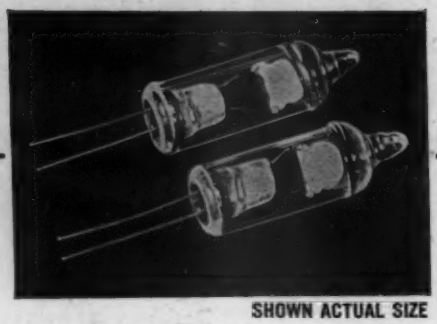
* Trade Mark registered.

All-Fibre Cans
Combination Metal and Paper Cans
Spirally Wound Tubes and Cores for All Purposes
Plastic and Combination Paper and Plastic Items

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVENUE CLEVELAND 2, OHIO

PRODUCTION PLANTS also at Plymouth, Wisc., Ogdensburg, N. Y. Chicago, Ill., Detroit, Mich., Jamesburg, N. J.
PLASTICS DIVISIONS at Plymouth, Wisc., Ogdensburg, N. Y. ABRASIVE DIVISION at Cleveland, Ohio
New York Sales Office—1186 Broadway, Room 223
IN CANADA—The Cleveland Container Canada Ltd., Prescott, Ontario

MINIGLASS* QUARTZ CRYSTAL UNITS†



SHOWN ACTUAL SIZE

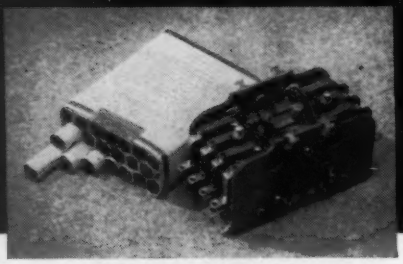
Compact — hermetically sealed — high performance — for multiple applications in the range of 2,500 to 10,000 kilocycles with a tolerance of ±250 cycles at room temperature . . . MINIGLASS* crystals are designed for your low cost quantity production items. Immediate delivery.

Manufacturers of Radio Quartz Crystals.

MELVIN L. SMITH LABORATORIES
KANE, PENNSYLVANIA

**Trade Mark* †*Patent applied for*

SIGMA 3 POSITION OUTPUT RELAY
FOR
CONTROL SYSTEMS
AND
SERVOMECHANISMS

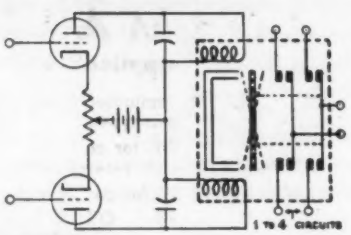


SIGMA TYPE 6 FX8A RELAY
Weight 8 Ounces
(Available Hermetically Sealed.)

This new relay by Sigma, already proven in months of development by prominent manufacturers of control and guiding equipment, overcomes many shortcomings previously inherent in relay-output control systems.

SPECIFIC ADVANTAGES

1. Positive snap centering or detent — no gradual motion.
2. True magnetic cancellation at balance — not affected by variations in standby current.
3. Exceptional sensitivity — approximately .005 watt differential power required per contact circuit.
4. Polarized magnetic circuit increases speed of action and facilitates discrimination as to polarity of error.
5. Fully balanced moving system withstands vibration to exceptionally high degree.
6. Flexible contact structure (maximum shown above) with substantial load handling ability (nominal rating 5 amp 110 Volts A.C. per contact).



SIGMA
Sigma Instruments, INC.
Sensitive RELAYS
62 Ceylon St., Boston 21, Mass.

ing from the Army as Brigadier General, he was Chief of Staff to the Commanding General of the Persian Gulf Command.

GEORGE F. METCALF, manager of General Electric's Electronics Laboratory at Syracuse, N. Y., was appointed an Honorary Officer of the

Colonel Metcalf (right), being decorated in Washington, D. C. by Lord Inverchapel, British Ambassador, for contributions to airborne radar while in the War Department and while serving as head of the Aircraft Radar Laboratories, Wright Field

Military Division of the Most Excellent Order of the British Empire.

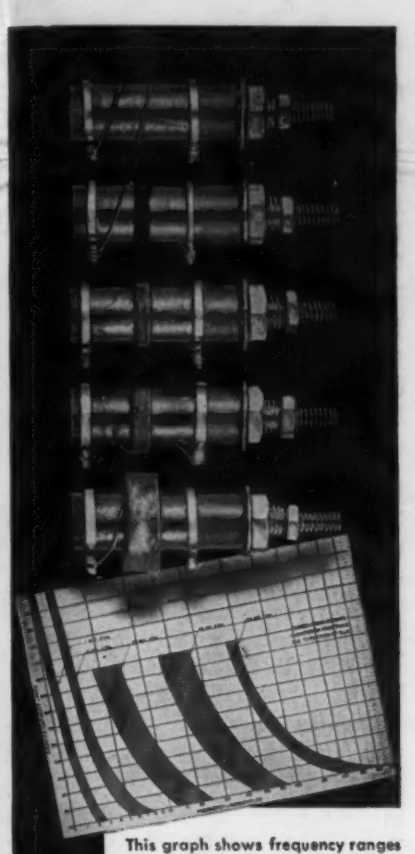
G. TAYLOR STANTON, formerly chief engineer of TelAutograph Corporation, New York, has been appointed manager of engineering of Holtzer-Cabot, specialized electric motor manufacturers.

JAMES D. MCLEAN, with General Electric in the radio, television, and radar fields for the past nine years, has recently been appointed manager of Philco television station WPTZ.

B. W. KENDALL, research consultant at Bell Telephone Laboratories, was elected second vice-president of the New York Electrical Society for the 1947-1948 term.

GEORGE C. W. BROWNE has just been appointed Controller of Radio, Department of Transport, in Ottawa, Canada.

DALE H. NELSON joined the Teleregister Corp., New York City, as consulting engineer to the Teleregister Laboratories Division. He was formerly research engineer at the



This graph shows frequency ranges covered by each unit. Write us for your full-size copy.

Five Standard Slug-Tuned LS3 Coils Cover ½ to 184 mc

For strip amplifier work, the compact (1¼" high when mounted) LS3 Coil is ideal. Also for Filters, Oscillators, Wave-Traps or any purpose where an adjustable inductance is desired.

Five Standard Windings—1, 5, 10, 30 and 60 megacycle coils cover inductance ranges between 750 and 0.065 microhenries.

CTC LS3 Coils are easy to assemble, one ¼" hole is all you need. Each unit is durably varnished and supplied with required mounting hardware.

SPECIAL COILS

CTC will custom-engineer and produce coils of almost any size and style of winding...to the most particular manufacturer's specifications.

Consult CTC for Three-Way Component Service

Custom Engineering . . . Standardized Designs . . . Guaranteed Materials and Workmanship

CAMBRIDGE THERMIONIC CORPORATION

437 Concord Avenue, Cambridge 38, Mass.

NEW BOOKS

The Radio Amateur's Handbook

By the HEADQUARTERS STAFF OF THE AMERICAN RADIO RELAY LEAGUE. *Published by the American Radio Relay League, Inc., West Hartford, Conn., 1947, Twenty-fourth Edition, 632 pages, $1.25.*

THE STANDARD manual of amateur radio communication has undergone its yearly revision and emerged, as usual, a source of handy and valuable information not only for the amateur but also for the engineer interested in practical radio applications. While the engineer might prefer to see revisions of a type that would eventually upgrade the book out of the amateur class, the editors wisely keep their volume in conformity with the subject matter contained in the amateur magazine *QST*. As an example, the lead-off article under receiver construction describes a two-tube superheterodyne, probably no more difficult to construct than the two-tube regenerative receiver that occupied a similar position in last year's Handbook. The single-tube transmitter is replaced by a crystal oscillator and amplifier combination that is little more expensive and a better performer. The sections on vhf equipment are likely to change most as techniques of using the higher frequencies are developed.

The fifty pages of vacuum-tube characteristics and data include base diagrams for socket connections covering more than a thousand tube types. This information alone is well worth the price of the entire volume.—A.A.McK.

Tables of Spherical Bessel Functions

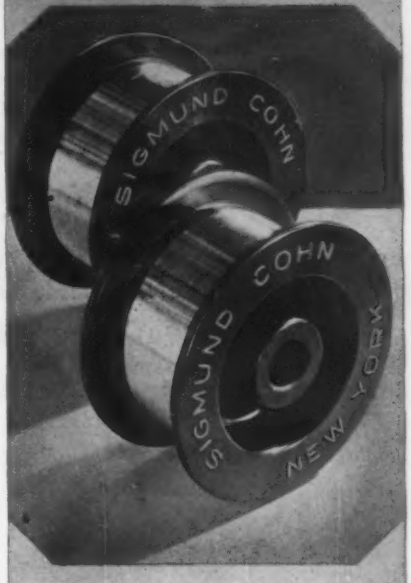
MATHEMATICAL TABLES PROJECT, NATIONAL BUREAU OF STANDARDS. *Columbia University Press, New York*, 1947, 375 *pages*, $7.50.

THE MAIN table gives the functions of orders $\pm (n + \frac{1}{2})$, where $n = 0(1)13$ and $x = 0(0.01)10(0.1)25$, as required for solution of problems of potential, heat conduction, and wave motion for a domain bounded internally or externally by a sphere, circular cone, or spheroid. The majority of entries are to seven or eight significant figures. The

PRECIOUS METALS

PLATINUM METALS

GOLD ALLOYS



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FOIL

RIBBON

WIRE

TUBING

WRITE for list of products

SIGMUND COHN & CO.

44 GOLD ST. NEW YORK

SINCE 1901

WELLER Soldering Gun

5 SECOND HEATING

Specially engineered lightweight transformer produces soldering heat in loop tip 5 seconds after trigger switch is closed. Acclaimed by radio servicemen nation-wide as a money maker.

DEPENDABLE

Always ready to use when picked up. Fast cooling makes it safe to lay down on bench.

100 Watts
115 Volts
60 Cycles

TROUBLE FREE

Thousands in daily use without any maintenance—some as long as 5 years. Nothing to break or burn out.

Get a Weller Soldering Gun from your radio parts distributor or write direct for bulletin.

WELLER MFG. CO. 806 Packer St., Easton, Pa.

In Canada: Atlas Radio Corp., Ltd., 560 King St., N. W., Toronto, Ont.
Export Dept.: 25 Warren St., New York 7, N. Y.

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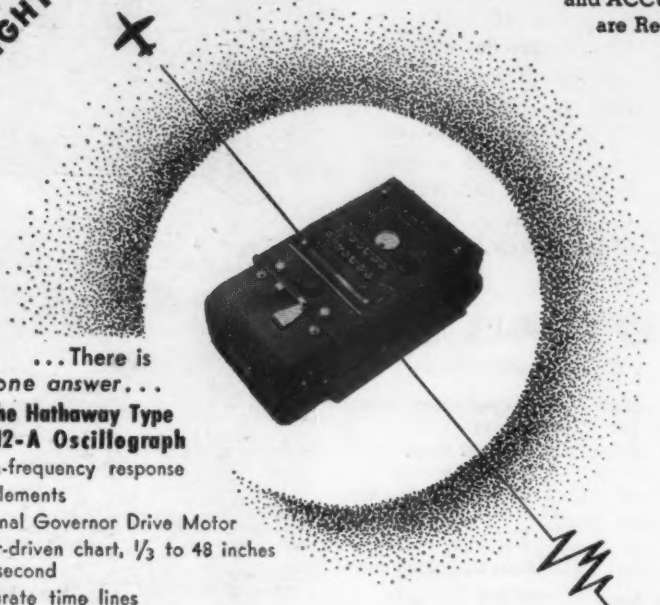

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for both commercial and military aircraft. Before joining RCA in 1945 he was chief engineer of the Radar Navigation Group in the AAF Radar Laboratories at Wright Field, where he had the responsibility for the technical development of shoran and airborne loran.

DAVID D. COFFIN, chief engineer of Raytheon Manufacturing Co.'s new Commercial Products Division in Waltham, Mass., has been with the company since 1934.

EVERETT G. FRAIM, identified with the Boston-New York microwave experimental communication system, is now engineer in charge of speech input equipment and microwave applications at the recently formed Commercial Products Division of Raytheon Manufacturing Co., Waltham, Mass.

JAMES N. NYE, engineer in charge of broadcast transmitter equipment at Raytheon's new Commercial Products Division, spent five years with Federal Telephone and Telegraph Co. working on the development of f-m transmitters.

EDWARD F. CAHOON has rejoined TelAutograph Corporation as chief engineer. He assumes full responsibility for engineering research and development on telescribing systems for instantaneous communications in writing.

FULTON CUTTING, former president and chairman of the board of directors of Colonial Radio Corporation, has been appointed assistant to the president for research and professor of physics at Stevens Institute of Technology. He organized the Colonial Radio Corp., Buffalo, N. Y., in 1924. As a member of the Operational Research Staff in the Office of the Chief Signal Officer during the war, he worked on radar countermeasures and counter-countermeasures (antijamming), guided missiles, and countermeasures against guided missiles, and was a member of the ALSOS Mission.

GEORGE L. BEERS, assistant director of engineering of the RCA Victor Division in Camden, N. J., received the honorary degree of Doctor of Science from Gettysburg College, Gettysburg, Pa.

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place accuracy. The introduction gives instructions for using the tables, along with several excellent examples of uses for logarithms. —J.M.

Relativity

By ALBERT EINSTEIN. *Hartsdale House, New York* 18, *N. Y.*, 168 *pages*, $2.50.

REPRINT of a book written in 1916 explaining Einstein's theory of relativity in simple words with a minimum of mathematics, and that essentially at the high-school level. This English translation, made in 1920 by R. W. Lawson, is offered as an atomic age source book.—J.M.

An Introduction to Engineering Plastics

By D. W. BROWN AND W. T. HARRIS. *Murray Hill Books, Inc, New York 16, N. Y., 274 pages, $4.00.*

OF PARTICULAR interest to the electronic engineer are highly readable chapters on x-ray examination of plastics, (4 pages), metal coating of plastics by electroplating and by spraying molten metal (11 pages) machining of plastics (20 pages) high frequency heating for processing plastics and welding thermoplastics (11 pages) and welding plastics. —J.M.

Electronic Engineering Patent Index

Edited by FRANK A. PETRAGLIA, *Electronics Research Publishing Co., New York, 1946, 467 pages, $14.50.*

PATENT abstracts of electronic devices as they appeared in the weekly *Official Gazette* of the U. S. Patent Office during 1946 have been arranged by type of subject device under some 90 classifications. The index forms a convenient guide for engineers to the latest techniques and devices.—F. R.

Employees Are People

By HARRY K. TOOTLE, *Personnel Director, New York Times. McGraw-Hill Book Co., Inc., New York, N. Y., 1947, $3.50.*

HUMAN relationships of personnel administration, briskly written, with hundreds of useful ideas for executive-minded engineers.—J.M.

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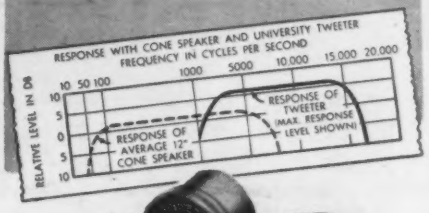
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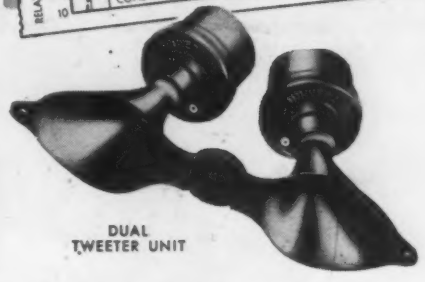

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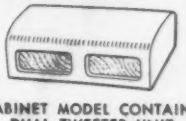

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tables given in this book make possible speedier solution of such varied problems as diffusion of a searchlight beam by fog, triggering of nuclear disintegrations by neutron collisions, and analysis of oscillation in uhf radio tubes.—J.M.

Electric Contacts

By RAGNAR HOLM. *Published by Hugo Gebers Forlag, Stockholm, Sweden,* 1946, 398 *pages.*

CIRCUIT breakers, relays, terminals, and microphones all operate with electric contacts. This volume has been written to describe the physics of contacts, to arrange fundamental formulas, and to present characteristics of materials in tabular form for use with the formulas. Friction has been treated in some detail because wear in sliding is fundamentally important in many types of contact. Descriptions of circuit-breaker phenomena have been limited to weak currents, partly because the long arcs experienced with heavy currents modify the general problem considerably.

The greater part of the work described was done while the author was employed as a physicist on the staff of the Research Laboratory of the Siemens Works in Berlin. The present volume owes much to a previous work by the author published in Berlin in 1941. —A. A. MCK.

Unified Calculus

By E. S. SMITH, M. SALKOVER, and H. K. JUSTICE. *John Wiley & Son, Inc., New York, N. Y.,* 1947, 507 *pages,* $3.50.

FIRST course in calculus, at college level, uniquely combining differential and integral calculus in early chapters to create an appreciation of the unity of the subject.—J.M.

Six-Place Tables

Edited by EDWARD S. ALLEN, *Professor of Mathematics, Iowa State College. McGraw-Hill Book Co., Inc., New York* 18, *N. Y., Seventh Edition,* 1947, 232 *pages,* $2.50.

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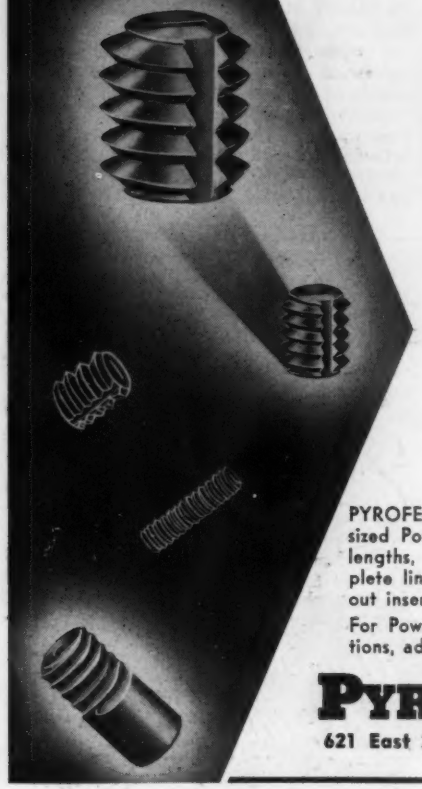

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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Television Herald

Dear Editor:

THIS LETTER is written in response to your recent editorial calling attention to the need for a simple device to warn television set owners that a special program is about to be offered.

Why not permit stations to use their f-m transmitters for commercial broadcasting during the hours when they are not transmitting pictures? Television receivers should be equipped with switches which would permit turning off the video portion of the receiver. Thus, the station would merely make an announcement that a special picture program would be transmitted at a certain time.

If this system were instituted it would provide more incentive for more people to spend more money in purchasing a combination receiver since they could get more use from it. This plan would also provide an added incentive to potential broadcasters of television programs since they could probably increase their station income sufficiently to break the economic bottleneck which currently is impeding the progress of television.

It is my opinion that people will pay a fair sum for a television receiver if some means can be found by which television stations can be placed on the air with fair programming and without bankrupting the station operator.

MERLE V. HOOVER
Susquehanna University
Selinsgrove, Penna.

Pentode as Cathode Follower

Dear Sir:

IN THE CATHODE FOLLOWER Nomograph, p 136, June issue of ELECTRONICS, unless the negative screen return (not shown) is made to the

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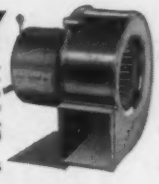

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supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.

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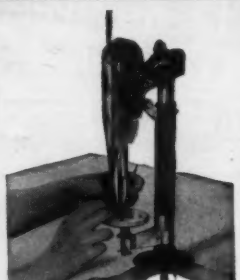

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cathode, rather than to ground, the equations and nomograph do not hold for a-c signals whose voltage swing is an appreciable portion of the d-c screen voltage.

This is because the tube ceases to be a pentode if the cathode to screen voltage is allowed to vary with the signal. If such variation is allowed, the manufacturer's tube parameters, particularly the mu and the dynamic plate resistance, are no longer valid.

For a-c amplifiers with relatively small signal voltage, this point is probably of small importance. For d-c amplifiers, it becomes so important that it is necessary to use a separate screen supply, connected between the floating cathode and the screen, if it is desired to obtain a value of A approaching 0.99 with any standard pentode.

The writer has designed much electrochemical equipment using an input buffer stage of this type to reduce grid current. It has been necessary to get the voltage gain as near to unity as possible in this stage for the sake of linearity of the instrument. This has required that the screen return be connected to the cathode, with a separate screen supply.

P. M. HACKETT,
Manager
Niagara Electron Laboratories
Andover, N. Y.

Lines for Tanks

Dear Mr. Fink:

I SHOULD like to report the following errors, besides the immediately obvious ones, in "Design of Transmission Line Tank Circuits," published in the May 1947 issue of ELECTRONICS.

(a) Equation 4—letter l is missing in l/λ term.

(b) Figure 2—ordinate should be labeled from 1×10^4 to 1×10^6.

(c) The right-hand side of Eq. 19 should be multiplied by 2.

(d) Citizen's Band Class-C Amplifier—Substitute R_s for Q. The final numerical answer is 4,520.

I should like to thank you and your staff for the excellent presentation, which I truly appreciate.

WALTER C. HOLLIS
Project Engineer
Sperry Gyroscope Co.
Great Neck, N. Y.

SEPTEMBER · 1947

electronics

A McGRAW-HILL PUBLICATION

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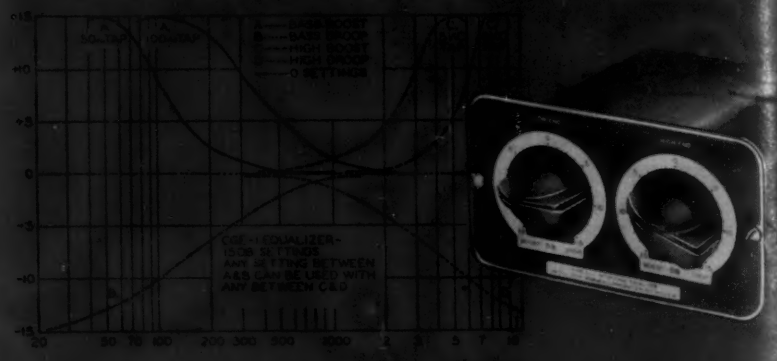

This new U T C unit is the ideal, simple device for any application requiring frequency response correction. Designed to be connected between two triode audio stages or to match a high impedance (5000 to 30000 ohms) source to grid.

The CQE-1 equalizer is not a simple R-C tone control, but employs resonant circuits to permit low or high end equalization without affecting mid-frequencies. With controls in center, no equalization is effected. Moving one control to left increases bass; to right, drops bass. Moving other control to left increases highs; to right drops highs. Controls are independent so that bass may be raised and highs dropped simultaneously, etc. Amount of equalization is continuously adjustable, up to 15 DB, panel calibrated in DB. The insertion loss effected is equal to the combined low frequency and high frequency settings plus 6 DB. Unless existent gain of equipment to which CQE-1 is added is high, an additional audio stage may be required.

This unit comes complete so that controls with etched panel may be mounted on a chassis (2½ inch minimum) or a panel with case containing the electrical elements held by etched panel screws.

CQE-1 Panel Dim. 2⅜ x 4. Wt. 2 lbs. List Price **$25.00**

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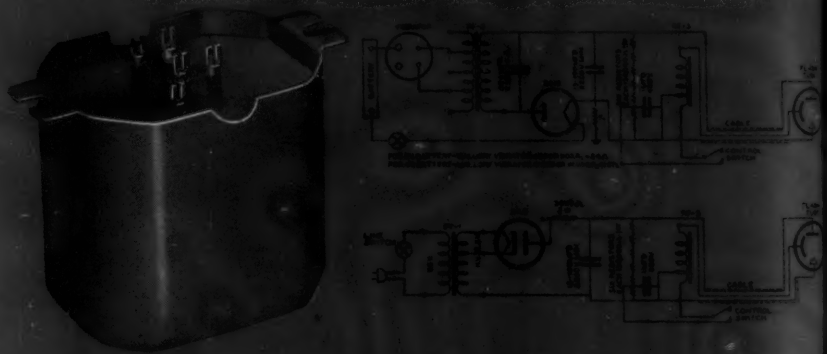

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PF-2 For portable photoflash service. Primary tapped for 4 volt or 6 volt battery (full wave vibrator). Secondary for power supply delivering 2200 volts DC to condenser up to 40 Mfd. (30 Mfd. charges in 20 Sec. with 6 volts or 28 Sec. with 4 volts). Compound sealed in G-3 case. Weight 2 Lbs. List Price . . . $10.00

PF-3 Trigger Transformer 15 KV peak . . . . . List Price . . . **$4.50**

For further circuit details, write for sheet #PF.

For Full Listings of UTC Items, Write for Catalogue PS-407

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electronics

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SEPTEMBER • 1947

FIELD STRENGTH MEASUREMENT ..... Cover
Determining pattern of transmitting equipment at Sylvania Center, Bayside, N. Y.

A MEMORY TUBE, by Andrew V. Haeff 80
Cathode-ray tube with dielectric screen retains image as long as necessary

A NEW TELEVISION PROJECTION SYSTEM, by W. E. Bradley and E. Traub 84
An improved phosphor and a directional viewing screen permit reception at high light levels

APTITUDE TESTER FOR GARMENT WORKERS, by E. C. Halliday, F. Anderson, and E. O. Garnett 90
Phototube, amplifier, and clock measure total time operator fails to follow wavy line on moving paper strip

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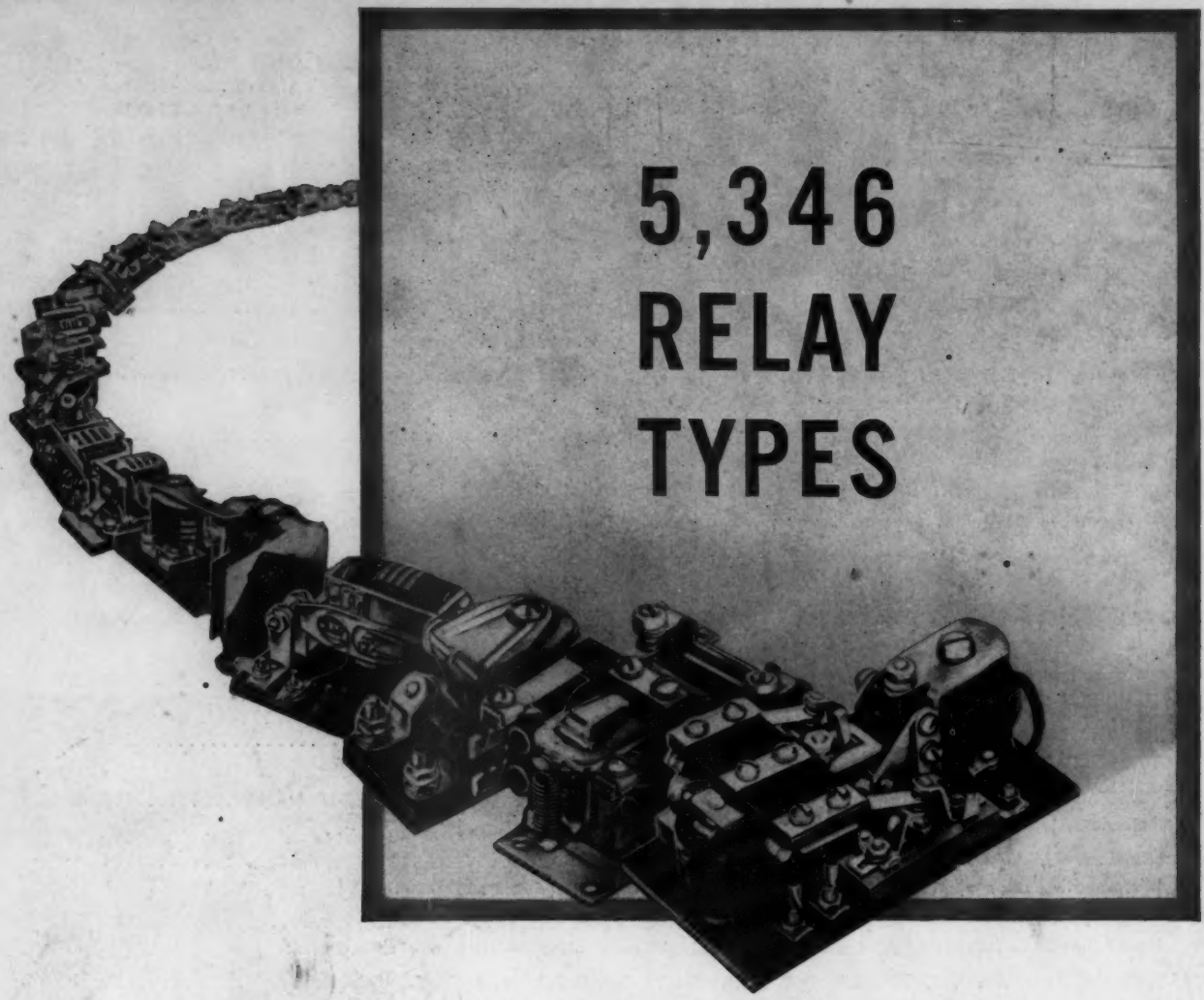

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